

NEWSLETTER

No. 89, November 2015

General information about the European
Photochemistry Association

is available at:

www.photochemistry.eu

Newsletter Editor: Prof. Maurizio D'Auria

*Dipartimento di Scienze
Università della Basilicata
85100 Potenza, ITALY*

© 2015 Dipartimento di Scienze, Università della Basilcata

ISSN 1011-4246

Printed in the United Kingdom by Media Services, Loughborough
University, Leicestershire LE11 3TU

CONTENTS

EPA EXECUTIVE COMMITTEE.....	6
2015 - INTERNATIONAL YEAR OF LIGHT.....	9
EDITORIAL	10
President's Letter	10
PUBLICATIONS	12
The photochemistry of the future	12
Interstellar photochemistry has shown to provide icy building blocks of life	27
PORTER MEDAL	31
The Porter Medal 2016 – Call for Nominations	31
EPA PRIZE	33
EPA Prize for Best PhD Thesis in Photochemistry - Call for Nominations	33
SPECIAL REPORTS ON "THE YEAR OF LIGHT"	34
Introduction.....	34
The international year of light and light-based technologies (IYL)	36
The international year of light and light-based technologies 2015 in down under	40
International year of light 2015 report on GDCh activities.....	44

Photo-Chemistry! Light, environmental monitoring and cancer fighting.....	54
Workshop on photochemistry (international year of light 2015).....	56
The international year of light - a personal and professional perspective	60
The international year of light and light-based technologies 2015 in Italy.....	66
New trends i photochemical engineering and technologies.....	71
PILLS OF HISTORY.....	74
At the origin of photochemistry. Leone Maurizio Padoa.....	74
EPA IS ON FACEBOOK.....	79
ABSTRACT OF THESIS ON PHOTOCHEMISTRY	80
ANNOUNCEMENTS.....	83
PHOTOCHEMICAL AND PHOTOBIOLOGICAL SCIENCES	85
MEMBERSHIP APPLICATION FORM	86

EPA EXECUTIVE COMMITTEE

President



Dr. David Worrall
Photochemistry Research
Group
Department of Chemistry
Loughborough University
Leicestershire
LE11 3TU, UK
Tel: +44(0)1509 222567
d.r.worrall@lboro.ac.uk

Newsletter Editor



Prof. Maurizio D'Auria
Dipartimento di Scienze
Università della Basilicata
Viale dell'Ateneo Lucano 10
85100 Potenza
Italy
maurizio.dauria@unibas.it

Treasurer



Dr. Alexandre Fürstenberg
Department of Human Protein
Sciences
University of Geneva
1211 Genève 4, Switzerland
Tel: +41 22 379 54 73
Fax: +41 22 379 55 02
Alexandre.Fuerstenberg@unige.ch

**Public Relations**

Prof. Dr. Olga Fedorova
A.N.Nesmeyanov Institute of
Organoelement Compounds
Russian Academy of Sciences
28 Vavilova St., Moscow
RUSSIA 119991
Tel: +7 499 135 8098
fedorova@ineos.ac.ru

**Past President and PPS matters**

Prof. Dr. Werner Nau
School of Engineering and
Science of Chemistry, Jacobs
University
Campus Ring 1
D-28759 Bremen
Germany
w.nau@jacobs-university.de

**Newsletter Associate Editor**

Prof. Julia Pérez-Prieto
Molecular Science Institute
(ICMOL)
Valencia University
C/ Catedrático José Beltrán, 2
46980-Paterna, Valencia, Spain
Tel: +34-96-3543050
julia.perez@uv.es

Website manager



Dr. John Gilchrist
Gilden Photonics Ltd.
Unit 13 Telford Court, 9 South
Avenue
Clydebank Business Park
Glasgow, G81 2NR, UK
Tel: +44(0)141.952.9475
john.gilchrist@gildenphotonics.com

New Information Technologies



Prof. Dr. Roberto Improta
Institute for Biostructures and
Bioimaging
Naples
robimp@unina.it



**INTERNATIONAL
YEAR OF LIGHT
2015**

EDITORIAL**President's Letter**

Dear Colleagues,

I'll start in traditional fashion, by commenting on the weather! In the UK this is unseasonably mild, although the rain brought by storm Desmond has caused significant issues in many areas. Not usual climate behaviour for the UK, but of course drawing conclusions from one-off measurements is always hazardous – however there is long-term consensus (see below).

Paris has been the focus of two recent very significant events. The first coincided with the Royal Society of Chemistry awards evening in Manchester on 13th November, where many of those assembled, linked in to social media, saw with increasing dismay and horror events unfolding over the course of the evening. A minute of silent reflection was held before the Saturday morning meeting session. The second, and fortunately much more positive event was the historic agreement on climate change made over the past weekend, with a commitment to restrict global warming to below 2 degrees celcius. Clearly an ambitious target, and renewables including solar energy will play an important role – innovative solar energy conversion materials will be to the fore. Whether a hydrogen economy based on photocatalytic water splitting will dominate the world economy or whether battery technology coupled to renewable energy will win the day remains to be seen, but solar energy looks set to be an important part of the mix for the foreseeable future.

I was put in mind from these musings on energy generation of a discussion session held at the XIX IUPAC Symposium on Photochemistry in Budapest in 2002, where (if memory serves) the hypothesis was that “traditional” photochemistry was the past and that the future lay with supramolecular photochemistry and functional devices. One could argue this has largely come to pass, although issues surrounding for example photodegradation mechanisms – “traditional” photochemical kinetic analysis – remain. Perhaps a new debate at a future conference may be worth considering.

2016 will see the presenting of three awards in the area of photochemistry. These are the *EPA-PPS Prize* for the most highly cited paper published in PPS during the previous two calendar years, the *EPA Prize for Best PhD Thesis in Photochemistry* published during the previous two calendar years, and the *Porter Medal*, in cooperation with our Inter-American and Asian/Oceanian photochemistry association counterparts, I-APS and APA.

Finally, a reminder about our Facebook page; please “like” us to keep up-to-date with conferences, job opportunities and general news.

Dr. David Worrall
Loughborough University

PUBLICATIONS

The Photochemistry of the Future

Giacomo Ciamician

I think the best way to conclude the year of light is to read the contribute that G. Ciamician published on Science. We have to thank the American Association for the Advancement of Science for the permission to publish here this article.

M.D'A.

Modern civilization is the daughter of coal for this offers to mankind the solar energy in its most concentrated form: that is in a form in which it has been accumulated in a long series of centuries. Modern man uses it with increasing eagerness and thoughtless prodigality for the conquest of the world and, like the mythical gold of the Rhine, coal is to-day the greatest source of energy and wealth.

The earth still holds enormous quantities of it, but coal is not inexhaustible. The problem of the future begins to interest us and a proof of this may be seen in the fact that the subject was treated last year almost at the same time by Sir William Ramsay before the British Association for the Advancement of Science at Portsmouth and by Prof. Carl Engler before the *Versammlung deutscher Naturforscher und Aerzte* at Karlsruhe. According to the calculations of Prof. Engler Europe possesses today about 700 billion tons of coal and America about as much; to this must be added the coal of the unknown parts of Asia. The supply is enormous but, with increasing consumption, the mining of coal becomes more expensive on account of the greater depth to which it is necessary to go. It must therefore be remembered that in some regions the deposits of coal may become practically useless long before their exhaustion.

Is *fossil* solar energy the only one that may be used in modern life and civilization? That is the question.

Sir William Ramsay has made a very careful study of the problem from the English point of view. He has considered the various sources of energy such as the tides, the internal heat of the hearth, the heat of the sun, water power, the forests and even atomic disintegration, and has come to the conclusion that none can be

practically used in England on account of her special contour and climate.

Though the internal energy of the earth may produce terrible disasters through volcanic eruptions and earthquakes, it can hardly be used by man. The energy derived from the rotation of the earth (tides) can hardly be counted upon on account of the enormous quantities of water that would have to be handled. Atomic disintegration has recently been treated in a brilliant lecture by Frederick Soddy, with special reference to the enormous energy changes which are involved. If man ever succeeds in availing himself of the internal energy of the atoms, his power will surpass by far the limits assigned to it today. At present he is limited to the use of solar energy. Let us see however whether the *actual* energy may not supplant that stored up in fossil fuel. Assuming that the solar constant is three small calories a minute per square centimeter, that is thirty large calories a minute per square meter or about 1800 large calories an hour. We may compare this quantity of heat with that produced by the complete combustion of a kilogram of coal, which is 8000 calories. Assuming for the tropics a day of only six hours sunshine we should have, for a day, an amount of heat equivalent to that furnished by 1.35 kg. of coal, or one kilogram in round numbers. For a square kilometer we should have a quantity of heat equivalent to that produced by the complete combustion of 1000 tons of coal. A surface of only 10,000 square kilometers receives in a year, calculating a day of only six hours, a quantity of heat that corresponds to that produced by the burning of 3650 million tons of coal, in round numbers three billion tons. The quantity of coal produced annually (1909) in the mines of Europe and America is calculated at about 925 million tons and, adding to this 175 million tons of lignite, we reach 1100 million tons or a little over one billion. Even making allowances for the absorption of heat on the part of the atmosphere and for other circumstances, we see that the solar energy that reaches a small tropical county – say of size of Latium – is equal annually to the energy produced by the entire amount of coal mined in the world! The desert of Sahara with its six million square kilometers received daily solar energy equivalent to six billion tons of coal!

This enormous quantity of energy that the earth receives from the sun, in comparison with which the part which has been stored up by the plants in the geological periods is almost negligible, is largely wasted. It is utilized in waterfalls (white coal) and by plants. Several

times its utilization in a direct form through mirrors has been tried, and now some very promising experiments are being made in Egypt and in Peru; but this side of the problem is beyond my power to discuss and I do not propose to treat it here.

The energy produced by water power during the period of one year is equal to that produced by 70 billion tons of coal according to the data given in Professor Engler's lecture. It is however very small, as might be expected, in comparison with the total energy that the sun sends to earth every year. Let us now see what quantity of solar energy is stored by the plants: on the total surface of the various continents, which is 128 million square kilometers, there is a yearly production of 32 billion tons of vegetable matter, which, if burnt, would give the quantity of heat that corresponds to the total combustion of 18 billion tons of coal. It is not much but even this is 17 times as much as the total present production of coal and of lignite.

I

Now let us consider the first part of our subject. Is it possible or, rather, is it conceivable that this production of organic matter may be increased in general and intensified in special places, and that the cultivation of plants may be so regulated as to make them produce abundantly such substances as can become sources of energy or be otherwise useful to civilization? I believe that this is possible. It is not proposed to replace coal by organic substances produced by plants; but it is conceivable that this organic matter may be utilized more satisfactorily than is now the case.

It has frequently been said even by persons of authority that some day the transformation of coal into bread may become not only possible but economically desirable. According to these people that ideal of the future should be to produce through synthesis from coal all substances necessary for the alimentation of man: such substances as starch, sugar and fat, also proteins and perhaps cellulose; in other words to abolish agriculture altogether and to transform the world into a garden of useless flowers. Never was a greater fallacy thought or expressed: the real problem is just the reverse of this. My friend Professor Angeli wisely called to my attention that, while the externals of life have been changed greatly by the progress of industry so as to use all our technical knowledge to increase our

comfort, the quality and quantity of human alimentation have hardly changed at all; nay, a new science has come into existence (bromatology) to see that no artificial product of industry enters harmfully into our alimentation. At the time of Napoleon III an attempt was made to substitute gelatine for meat; but it was seen very soon – and now the reason for it is known by all – that this substitute could not be sufficient to maintain life. With the relatively small reserves of coal that the past geological epoch have stored for us, it will never be desirable to produce from coal what nature generously offers us through solar energy. It is on the other hand a work worthy of praise to attempt to make plants produce the fundamental substances in larger quantity. Modern agriculture tries to do this by intensive cultivation; but it is also desirable to make the plants store up solar energy and transform it into mechanical energy.

A well-known instance of this occurred when the development of the daily press in all civilized countries made it imperative to provide wood pulp in a sufficient quantity and at low prices. Trees, better adapted to the purpose, were soon found and they were those which, on account of their rapid growth, could furnish the necessary cellulose sooner. For the problem we are now considering the quality of the plants is of secondary importance; they may be herbs or trees; they may grow in swamps or dry places, on the sea coast or even in the sea; the essential point is that they grow fast or that their growth may be intensified. It would be like realizing the desire of Faust:

“Und Bäume die sich täglich neu begrüen!”

Mephistopheles did not consider a similar task impossible:

“Ein solcher Auftrag schreckt mich nicht,
Mit solchen Schätzen kann ich dienen”

Should we consider the task impossible, naturally in a more limited sphere, after so many centuries of culture? I do not believe so. The above estimate of the total production of organic matter over all the solid surface of the earth, that is of 32 billion tons a year, has for its basis the old calculation of Liebig of 2.5 tons per hectare. This may be considered even to-day the average production for all the earth. According to A. Mayer, through intensified culture the production may be increased to 10 tons per hectare and in tropical climates it may reach 15 tons. On a square kilometer it would be 1500 tons, corresponding to 840 tons of coal, while the solar energy received in a year by a square kilometer would be equivalent to about 300,000 tons of coal, the part of the total energy stored up by the plants being

about 1/300. A great deal remains to be done, but if we consider that since Liebig, largely by adopting the methods proposed by him, the production has been at least quadrupled, we may hope to do much more in the future, especially if we are spurred on by necessity or even by convenience.

By increasing the concentration of carbon dioxide up to an optimum value (1 to 10% according to Kreuzler) and by using catalyzers, it seems quite possible that the production of organic matter may be largely increased, making use, of course, of suitable mineral fertilizers and selecting localities adapted to the purpose owing to the climate or the condition of the soil. The harvest, dried by the sun, ought to be converted, in the most economical way, entirely into gaseous fuel, taking care during this operation to fix the ammonia (by the Mond process for instance) which should be returned to the soil as nitrogenous fertilizer together with all the mineral substances contained in the ashes. We should thus get a complete cycle for the inorganic fertilizing substances, the only waste being that common to all industrial processes. The gas so obtained should be burnt entirely on the spot in gas engines and the mechanical energy thus generated should be transmitted elsewhere or utilized in any way that seems advisable. We need not go into details. The carbon dioxide, resulting from the combustion, should not be wasted but should be returned to the fields. Thus the solar energy, obtained by rational methods of cultivation, might furnish low-priced mechanical energy, perhaps better than through the systems based on mirrors, because the plants would be the accumulators of the energy received by the earth.

But the problem of the utilization of plants in competition with coal has another and more interesting side. First of all we must remember the industries which have their basis in agriculture: the cotton and other textile industries, the starch industry, the production of alcohol and of all fats, the distillation of wood, the extraction of sugar, the production of tanning substances and other minor industries. All these industries are susceptible of improvement not only by the introduction of more advantageous technical devices in the treatment of the raw materials but also by a largely increased production of the raw materials. Let us think for an example of the progress made in the production of beet sugar.

The plants are unsurpassed masters of – or marvelous workshops for – photochemical synthesis of the fundamental substances, building up from carbon dioxide with the help of solar energy. They also

produce the so-called secondary substances with the greatest ease. These latter are usually found in the plants in small quantity and are of value for special reasons. The alkaloids, glucosides, essences, camphor, rubber, coloring substances and others are of even greater interest to the public than the fundamental substances on account of their high commercial value. In this field a battle is raging between chemical industry and nature, a battle which does honor to human genius. Up to now the products prepared from coal tar have almost always been triumphant. I do not need to remind you the various victories; but it is possible that these may prove to have been Pyrrhic victories. A great authority on organic industries considered recently what would happen in case, for any reason, there were a rapid increase in the price of coal tar and consequently of the substances contained in it. He pointed out the inevitable effect of this on the coal tar industries. We all remember with admiration the story of the great difficulties that had to be met in the choice of the raw material for the production of indigo. It was necessary finally to use naphthalene because toluene could not be obtained in sufficient quantity. But it is not merely through a rise in the price of the raw materials that an industry may suffer; it may be brought to standstill by a diminished interest and activity in a certain field of scientific study. It has been thoroughly established that modern industry is affiliated very intimately with pure science; the progress of one determines necessarily that of the other. Now the chemistry of benzene and its derivatives does not constitute the favorite field of research as it did during the second half of the last century. The centre of interest is now to be found in the matters and problems connected with biology. Modern interest is concentrated on the study of the organic chemistry of organisms. This new direction in the field of pure science is bound to have its effect on the technical world and to mark out new paths for the industries to follow in the future.

It is a fact that lately several organic industries have been successfully developed, outside of the field of benzene and coal tar. There are flourishing industries in essences and perfumes and in some alkaloids, like coca. In these industries products, which plants produce in relatively large amounts, are converted into products of higher commercial value. For instance everybody knows that essence of violet is now made from citral contained in lemon oil. This is a line along which we ought to follow because we are certain of making

progress. It is to be hoped that in the future we may obtain rubber commercially in some such way.

The question has still another side, which I believe deserves your attention; it concerns certain experiments recently made by myself together with Professor Ravenna at Bologna. It is not because we have arrived at any practical results that I refer to these experiments; but because they show definitely that we can modify to a certain extent the chemical processes that take place during the life of the plants. In a series of experiments made in an effort to determine the physiological function of the glucosides, we have succeeded in obtaining them from plants that usually do not produce them. We have been able, through suitable inoculations, to force maize to synthesize salicine. More recently, while studying the function of the alkaloids in the plants, we have succeeded in modifying the production of nicotine in the tobacco plant, so as to obtain a large increase or a decrease in the quantity of this alkaloid. This is only a beginning, but does it not seem to you that, with well-adapted systems of cultivation and timely intervention, we may succeed in causing plants to produce, in quantities much larger than the normal ones, the substances which are useful to our modern life and which we now obtain with great difficulty and low yield from coal tar? There is no longer at all of using for industrial purposes land which should be devoted to raising foodstuffs. An approximate calculation shows that on the earth there is plenty of land for both purposes, especially when the various cultivations are properly intensified and rationally adapted to the conditions of the soil and the climate. This development is a real problem of the future.

II

Technical organic industry may yet expect great help from photochemistry understood in the sense above expressed and in the competition between this and the chemistry of coal tar will be a great incentive for new progress. It is also true that human genius will always tend to proceed along lines selected by itself, and there is no question but that the great development in the coal tar industry has been due in part to this splendid spirit of independence. It may be asked whether there are not other methods of production which may rival the photochemical processes of the plants. The answer will be given by the future development of photochemistry as applied to the

industries and on this I have a few ideas to express. The photochemical processes have not had so far any extensive practical application outside of the field of photography. From its very beginning photography has aroused a great deal of interest: it was taken up technically and, as usually happens in similar cases, it had a rapid and brilliant success. But notwithstanding the many applications photography represents only a small part of photochemistry. So far, photochemistry has only been developed to a very slight extent, perhaps because chemists have been attracted by problems which seemed more urgent. So it happens that while thermochemistry and electrochemistry have already reached a high degree of development, photochemistry is still in its infancy. Now, however, we notice a certain awakening due to a series of studies concerning general problems and special processes, especially in the organic field, in which my friend Dr. Paul Silber and myself have taken an active part. Two recent publications, one of Plotnikow and the other by Benrath bear witness to this. But much remain to be done both in theoretical and general photochemistry as well as in the special branches. The photochemical reactions follow the fundamental laws of affinity, but have a special character. They are especially notable for the small temperature coefficient and are, however, comparable – a fact which is not without technical importance – to the reactions which take place at very high temperatures. According to a brilliant idea of Plotnikov, luminous radiations produce a different ionization from that due to electrolytic dissociation; the separation of an ion requires a quantity of light which is determined by the theory of Planck and Einstein. The question is therefore related to the most recent and profound speculations of mathematical physics.

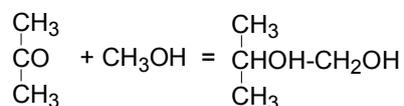
For our purposes the fundamental problem from the technical point of view is how to fix the solar energy through suitable photochemical reactions. To do this it would be sufficient to be able to imitate the assimilating processes of plants. As is well known, plants transform the carbon dioxide of the atmosphere into starch, setting free oxygen. They reverse the ordinary process of combustion. It has always seemed probable that formaldehyde was the first product of the assimilation; and Curtius has at last demonstrated its presence in the leaves of the beech trees. The artificial reproduction of a similar process by means of ultraviolet rays has already been obtained by D. Berthelot. With convenient modifications could not this now actually

be done on the tropical highlands? Yet the true solution consists in utilizing the radiations that pass through the entire atmosphere and reach the surface of the earth in large amounts. That a way of accomplishing this exists is proved by the plants themselves. By using suitable catalyzers, it should be possible to transform the mixture of water and carbon dioxide into oxygen and methane, or to cause other endo-energetic processes. The desert regions of the tropics, where the conditions of the soil and of the climate make it impossible to grow any ordinary crops would be made to utilize the solar energy which they receive in so large a measure all the year, that the energy derived from them would be equal to that of billions of tons of coal.

Besides this process, which would give new value to the waste products of combustion, several others are known, which are caused by ultraviolet radiations and which might eventually take place under the influence of ordinary radiations, provided suitable sensitizers were discovered. The synthesis of ozone, of sulphur trioxide, of ammonia, of the oxides of nitrogen, as well as many other syntheses, might become the object of industrial photochemical processes.

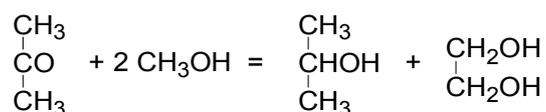
It is conceivable that we might make photoelectrical batteries or batteries based on photochemical processes, as, for instance, in the experiments of C. Winther.

Passing to the field of organic chemistry, the reactions caused by light are so many that it should not be difficult to find some which are of practical value. The action of light is especially favorable to processes of reciprocal oxidation and reduction which give rise to or are associated with phenomena of condensation. Since the common condensation is that of the aldolic type there is much hope for the future, the aldolic condensation being the fundamental reaction of organic synthesis. Some experiments recently made by my friend Silber and by myself may serve here as an illustration. The simplest case is that of the action of light on a mixture of acetone and methyl alcohol in which

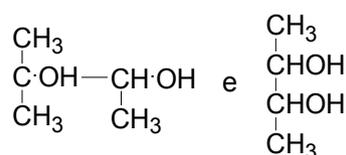


Isobutylene glycol is produced. But this condensation which may be considered as a simultaneous process of oxidation and reduction, is accompanied by the reduction of the ketone to isopropyl alcohol and

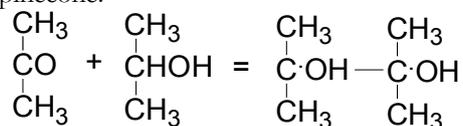
by the oxidation of the methyl alcohol to formaldehyde, which latter however, does not remain as a product which can be isolated because it reacts with the remaining methyl alcohol and is transformed into ethylene glycol:



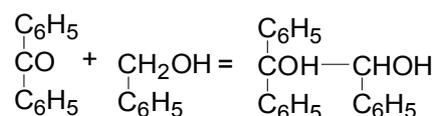
Applying the same photochemical reaction to the mixture of acetone and ethyl alcohol we have analogous products: trimethylene glycol and along with this isopropyl alcohol and dimethylethylene glycol:



With acetone and isopropyl alcohol, as could be expected, there is formed only pinecone:

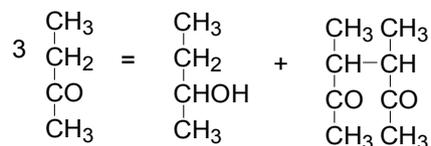


In the aromatic series benzophenone and benzyl alcohol give triphenylethylene glycol, together with other products:



This was the first case in which this condensation has been observed; others were afterwards studied by Paternò, who replaced the benzyl alcohol by several other aromatic substances. The observations of Klinger showed that the aldehydes also underwent condensations and this has since been confirmed by Benrath.

To get an idea of the variety of photochemical reactions we may confine ourselves to a systematic study of the ketones and alcohols. In ordinary organic chemistry the reactions often take place in some definite way; but the photochemical reactions often furnish surprises and proceed along quite different lines. From the very first experiments we knew that benzophenone did not form addition products with ethyl alcohol, but was converted into pinecone at the expense of the alcohol, which was oxidized to aldehyde. Proceeding with the study of aliphatic ketones, similar to acetone, we have this year discovered a remarkable fact. Methyl ethyl ketone condenses with itself and forms the paradiketone, reducing itself at the same time to secondary butyl alcohol:

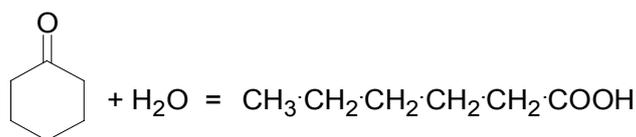


Of course the synthesis of diketones by light could not an isolated reaction; we had previously noticed the formation of diacetyl: acetylacetone is found, as we now know, among the products of acetone in solution in ethyl alcohol and it is also possible that the metadiketones, such as acetylacetone for instance, may be prepared photochemically. These reactions have a special importance on account of the special character of the diketones and their tendency to change in all sorts of ways. From them derivatives of benzene can be obtained as well as of pyrazol and isoxazol, of quinoline, of furfural, of thiophene and of pyrrol. In regard to this last change I wish to remind you that tetramethylpyrrol corresponds to the paradiketone previously referred to. If I dare to be reckless, as you may see I am at this moment, contrary to my custom, but perhaps urged thereto unconsciously by the American genius which heeds no obstacles, I may refer to the relations between the polysubstituted pyrrols with alcohol radicals and chlorophyll, and I may see in these reactions the possibility of the synthesis of this fundamental substance by means of an artificial photochemical process. Its formation in plants, like its function, is due to a photochemical process; we do not know, however, whether and in what measure light enters into all the synthetic plant reactions, from which originate

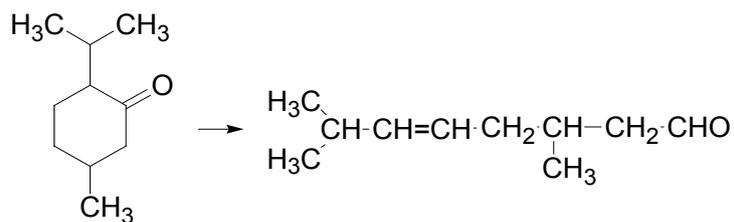
the various substances which we find in plants. The research should proceed together in two fields; phytochemistry and photochemistry will be of great help one to another. Industrially this co-operation might have a great future: the raw materials obtained from the plants might be refined through artificial photochemical processes.

Lately we have been interested intensely by the changes that some substances of the group of the terpenes and of the camphors undergo when exposed to light, especially through hydrolytic processes. So far, indeed, our experiments have taught us that light can spoil rather than improve essences.

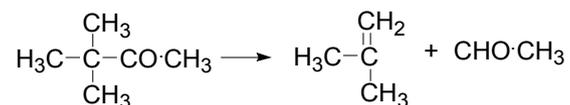
The cycloketones, for instance, are hydrolyzed and give the corresponding fatty acids; the cyclohexanone gives capronic acid and menthone gives decylic acid.



In photochemistry, however, one reaction does not exclude the other; the reactions may be reversed as some recent experiments with ultraviolet rays demonstrate; for the ultraviolet rays sometimes reverse reactions caused by less refrangible radiations. It is important to find suitable sensitizers and catalyzers. We can see what the future has in store for us from such reactions as the photolysis of the ketones, which often accompanies the hydrolysis, and by means of which we prepare isocitronellal, for instance from menthone,



or the transformation of camphor into an unsaturated cycloketone, etc. The analogous breaking down of pinacolone into butylenes and acetic aldehyde



Is remarkable because it demonstrates what violent decompositions light may cause. It may be an enemy, but just on account of that it is necessary to be familiar with the weapons of the adversaries in order to be able to conquer them and avail ourselves of their strength.

I do not believe, however, that the industries should wait any longer before taking advantage of the chemical effects produced by light. The polymerizations, the isomeric changes, the reductions and oxidations with organic and inorganic substances, and the autoxidations which light causes so easily should already find profitable applications in some industries if researches were carried out carefully with this in mind. The action of light on nitric and nitrosilic compounds, as we know it from experience, is one that ought to be utilized profitably. Our own transformation of orthonitrobenzoic aldehyde into nitrosobenzoic acid has recently been studied by various chemists, and has been made use of by Pfeiffer, who prepared a nitrophenylisatogen from chlorodinitrostilbene. This reminds us of the not less known transformation of benzylidene orthonitroacetophenone into indigo by Engler and Dorant and makes us foresee a new field in the photochemical production of artificial colors and dye-stuffs. The scope of studies on this subject ought not to be limited to preserving colors from fading, bleaching and all changes produced by light. The photochemistry of colors and dye-stuffs ought to furnish new methods of preparation and of dyeing. Very encouraging experiments have already been made with diazoic compounds and mention should be made of the recent observation of Baudisch that α -nitrosophthalylhydroxylamine is changed on the fibre to azoxynaphthalene when exposed to light. The autoxidation of leuco compounds by light is an old practice of which the ancients availed themselves for preparing purple; now the process is explained, thanks to the familiar researches of Friedlander, but it is clear that a great deal remains to be learned in this field.

Phototropic substance, which often assume very intense colors in the light, and afterwards return in the darkness to their primitive color, might be use very effectively. Such substances might well attract the

attention of fashion rather than fluorescent materials which give the impression of changing colors. The dress of a lady, so prepared, would change its color according to the intensity of light. Passing from darkness to light the colors would brighten up, thus conforming automatically to the environment: the last word of fashion for the future.

Solar energy is not evenly distributed over the surface of the earth; there are privileged regions, and others that are less favored by the climate. The former ones would be the prosperous ones if we should become able to utilize the energy of the sun in the way which I have described. The tropical countries would thus be conquered by civilization which would in this manner return to its birth-place. Even now the strongest nations rival each other in the conquest of the lands of the sun, as though unconsciously foreseeing the future.

Where vegetation is rich, photochemistry may be left to the plants and by rational cultivation, as I have already explained, solar radiation may be used for industrial purposes. In the desert regions, unadapted to any kind of cultivation, photochemistry will artificially put their solar energy to practical uses.

On the arid lands there will spring up industrial colonies without smoke and without smokestacks; forests of glass tubes will extend over the plains and glass buildings will rise everywhere; inside of these will take place the photochemical processes that hitherto have been the guarded secret of the plants, but that will have been mastered by human industry which will know how to make them bear even more abundant fruit than nature, for nature is not in a hurry and mankind is. And if in distant future the supply of coal becomes completely exhausted, civilization will not be checked by that, for life and civilization will continue as long as the sun shines! In our black and nervous civilization, based on coal, shall be followed by a quieter civilization based on the utilization of solar energy, that will not be harmful to progress and to human happiness.

The photochemistry of the future should not however be postponed to such distant times; I believe that industry will do well in using from this very day all the energies that nature puts at its disposal. So far, human civilization has made use almost exclusively of fossil solar

energy. Would it not be advantageous to make better use of radiant energy?

Interstellar photochemistry was shown to provide icy building blocks of life

Uwe J. Meierhenrich

Institut de Chimie de Nice (ICN), Université Nice Sophia Antipolis, 28 Avenue Valrose, 06108 Nice

Uwe.Meierhenrich@unice.fr

Where did the molecular ingredients for life on Earth come from? Many scientists think the basic chemical building blocks for biology were delivered via comets, but the building blocks – and the building process – remain a mystery.

In 2015 an international team led by Prof. Dr. Meierhenrich at the University Nice Sophia Antipolis has found lab-based evidence that a class of complex organic molecules evolved by photochemical reactions in the ice of star-forming clouds – and could be a potential source for the organic matter that allowed life on Earth to emerge. The findings, published in the *Proceedings of the National Academy of Sciences* 112, 2015, 965–970, could also offer a chemical tip sheet for the European Space Agency's comet-chasing Rosetta mission, giving it hints as to which chemicals to look for.

The team was interested in what are called "evolved interstellar ices." These ices hang out in dense molecular clouds that give birth to a star and its surrounding solar system. As the star forms and the planets and comets and asteroids coalesce out of this debris, these ices are incorporated within them. The ices contain many familiar molecules: water, carbon monoxide, carbon dioxide, methanol, ammonia and methane – some of which are found on Earth in biological contexts. Comets or asteroids packed full of these ices could have delivered life-giving molecules to Earth, the thinking goes.

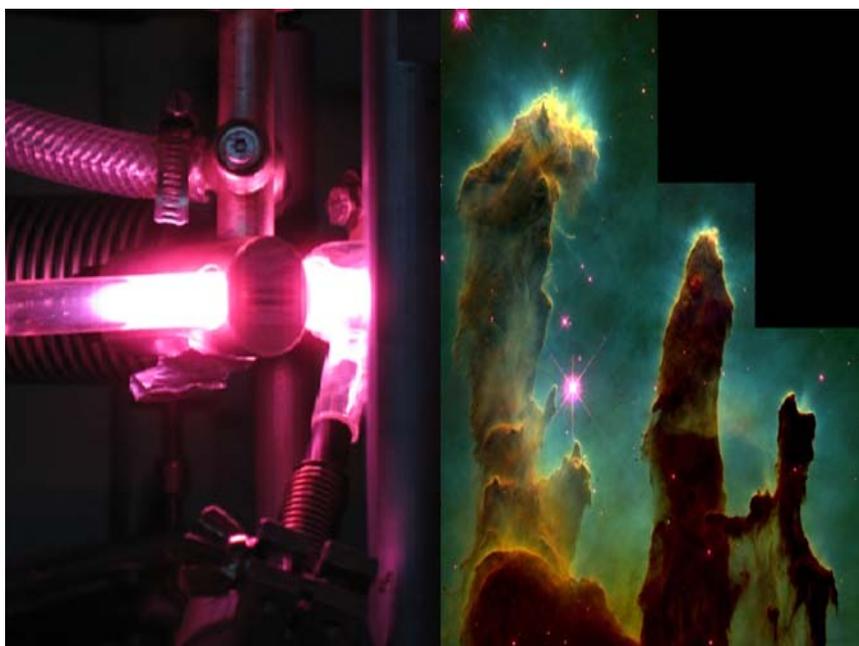


Figure : *Ultraviolet processing of interstellar ice analogues (left) may represent a template of the natural evolution of interstellar ices observed in molecular clouds (right) and leading to the simultaneous formation of amino acids and sugars (de Marcellus et al., Proceedings of the National Academy of Sciences 112, 2015, 965–970)*

However, it takes a lot of photochemistry to get from simple molecules to the complex strings that make up a macromolecule such as RNA (which is what scientists think coded the genetic instructions for living things before the emergence of DNA). How and where did all that chemistry happen? As it turns out, a lot of photochemistry is happening in the supposedly dead emptiness of space. It may not sound as conducive to cooking up complex organic molecules as the bubbling "primordial soup" we picture on early Earth, but space can be a chemically dynamic place, too. Ultraviolet radiation can produce radicals in the ice that recombine into ever-more-intricate molecules over time.

So, the photochemistry happening in this space ice could be doing a lot of grunt work before these molecules ever reach a planet, producing the kinds of complex organic compounds that would be essential for life to emerge. And since stars in general form out of these ice-filled molecular clouds, it could be happening all over the place. It could be the same way that organic molecules are delivered to life-friendly exoplanets, too. Possibly at the origin of the organic matter in our solar system and incorporated into planetesimals, this material may be considered as a potential source for prebiotic chemistry on rocky planets, following a process that may be quite universal. The problem is, it's not easy to study the evolution of these ices in the vastness of outer space. So the scientists set up an experiment in the laboratory where they could simulate the conditions of outer space, and watch what compounds were made when they subjected the basic starting materials (i.e. water, methanol, ammonia) to the harsh interstellar photochemical processes.

Previous photochemical work of the Meierhenrich team published in *Nature* 416, **2002**, 403–406 had turned up many intriguing organic compounds, including amino acids – essential molecules that today serve as the building block of proteins. But in this new experiment, the scientists actually found a whole other class of compound called aldehydes – 10 of them, including two sugar-related molecules called glycolaldehyde and glyceraldehyde. These two sugar-related compounds are considered as key prebiotic intermediates in the first steps toward the synthesis of ribonucleotides in a planetary environment. So this lab-based experiment reveals that these interstellar ices could hold the potential starting materials for RNA – and thus, so could any comet or asteroid that coalesced out of these ices (provided they haven't been altered beyond recognition in the intervening billions of years).

Evidence in the lab is one thing. The next step would be to actually identify these compounds in their natural setting, perhaps by using the new Atacama Large Millimeter Array telescopes to look for glyceraldehyde. Both compounds could be searched for in comets as well in certain carbonaceous chondrite meteorites. The findings also provided useful guidance for the Rosetta mission, whose Philae lander touched town on Comet 67P/Churyumov-Gerasimenko on November 12th, 2014 and woke up in June 2015. Philae's Cometary

Sampling and Composition (COSAC) instrument has a device that's designed to look for such organic molecules. A first set of organic molecules identified by COSAC after landing on the cometary nucleus will be published in July 2015 in *Science* (Goesmann, Meierhenrich et al. *Science*, **2015**, manuscript accepted for publication).

PORTER MEDAL

The Porter Medal 2016 – Call for Nominations

The Porter Medal is awarded every two years to the scientist who, in the opinion of the European Photochemistry Association, the Inter-American Photochemistry Society, and the Asian and Oceanian Photochemistry Association, has contributed most to the subject of Photochemistry. The Porter Medal, named for the late George Porter FRS, Nobel Laureate, is awarded biannually to the scientist who in the opinion of the judges, has contributed most to the science of photochemistry with particular emphasis on more physical aspects, reflecting George Porter's own interests.

To nominate European candidates for The Porter Medal 2016, candidate's details should preferably be sent directly to the President of the European Photochemistry Association, Professor David Worrall (d.r.worrall@lboro.ac.uk). For nomination of candidates from other continents, see the Porter Medal webpage: <http://www.portermedal.com>. Nominations may also be sent to the Chair of the Porter Medal Committee, Professor David Klug. The nomination package should include:

- Curriculum Vitae of the candidate
- A list of publications
- A citation for the award, not exceeding five pages
- Two letters of reference

Provisional closing date for the receipt of nominations (based on the guidelines from previous years) will be 31 January 2016.

Previous winners:

- 1988 Lord Porter (George Porter), UK (Founding medal)
1990 Michael Kasha, USA

- 1992 Kinichi Honda, Japan
- 1994 Nicholas J. Turro, USA
- 1995 J.C. "Tito" Scaiano, Canada (Special Medal for London ICP)
- 1996 Noboru Mataga, Japan
- 1998 Frans de Schryver, Belgium
- 2000 Vincenzo Balzani, Italy
- 2002 Josef Michl, USA
- 2004 Graham R. Fleming, USA
- 2006 Howard E. Zimmerman, USA
Hiroshi Masuhara, Japan
- 2008 Michael R. Wasielewski, USA
- 2010 David Philips, UK
- 2012 Thomas J. Meyer, USA
- 2014 Masahiro Irie, Japan

EPA PRIZE**EPA Prize for Best PhD Thesis in
Photochemistry
Call for Nominations**

The EPA Prize for the best PhD thesis in photochemistry will be attributed during the CECF 2016 Meeting which will be held in Bad Hofgastein, Austria, in 2016. The awardee will present his/her work at the Symposium. The Prize is 1000 Euros, plus travel costs to Bad Hofgastein (within the limit of 300 €) and one free year of EPA membership. The candidate must have defended his/her PhD thesis in 2014/2015 and be nominated by an EPA member. Nominations should be sent (electronically only) to David Worrall (d.r.worrall@lboro.ac.uk). The nomination package should include:

- Curriculum Vitae of the candidate
- Copy of the thesis
- Abstract of thesis in English, no more than five pages
- List of publications arising from the thesis
- A letter of support.

Closing date for the receipt of nominations will be 31 December 2015.

Previous winners:

- 2008 Maria Abrahamsson (thesis supervisor: Leif Hammarström), Sweden, Alexandre Fürstenberg (thesis supervisor: Eric Vauthey), Switzerland
- 2010 Anne Kotiaho (thesis supervisor: Helge Lemmetyinen), Finland
- 2012 Karl Börjesson (thesis supervisor: Bo Albinsson), Sweden
- 2014 Giuseppina La Ganga (thesis supervisor: Sebastiano Campagna), Italy

SPECIAL REPORTS ON "THE YEAR OF LIGHT"

Introduction

Dear EPA members,

This year is a special one in our field of research. The EPA Newsletter is a good vehicle for reporting all the efforts made by experts in this area related to the "International Year of Light". The International Year of Light aims to communicate to society, at different levels of knowledge, the relevance of light in our lives, its presence in current and future technologies, and its potential for environmental remediation, among other advantages. The December 2015 issue is dedicated to collecting information about the events/activities of the "International Year of Light".

Researchers from different countries have provided information and/or webpage links reporting on activities performed in their country and all over the world as well as a general history of light and a discussion on future research challenges in this area. In this issue, *Silvia Braslavsky* informs and gives webpage links of a large number of activities that have been carried out in different countries on the occasion of the IYL or activities that will be celebrated in December or the beginning of 2016. *Michael Oelgemöller* provides information on a special issue of the *Australian Journal of Chemistry* with contributions by relevant photochemistry researchers and reports on exhibitions on ongoing research activities in photochemistry and photophysics in Australia. In addition, *Michael Oelgemöller* and *Karine Loubiere* reports on a special issue of the journal *Chemical Engineering & Technology* in recognition of the IYL and light-based technologies. *Michael Tansch* and *Axel Griesbeck* reflect on how to introduce basic photochemistry/photophysics at school and at university so that many occurrences in our lives, as well as technological developments, do not go unnoticed whatever the student's level of scientific knowledge. Information on activities carried out by researchers from the German Chemical Society involved in photochemistry in basic and applied research is also given. In addition, activities focused on teaching photophysics/photochemistry at all levels with valuable and attractive experiments are discussed. *Guillermo Orellana* informs on a hands-on workshop for 11th grade high school students in Madrid

and *Maria González Béjar* reports on a workshop for graduate and undergraduate students at the University of Valencia and other activities in the Valencian region. *Malcolm D. E. Forbes* provides a general history of light and its applications, as well as future research challenges in many research areas in which light is the origin of the subsequent processes.

The EPA committee is very grateful to all of you who have collaborated in this issue.

Julia Pérez-Prieto
Associate Editor EPA Newsletter
Universidad de Valencia
Instituto de Ciencia Molecular (ICmol)
C/ Catedrático José Beltrán 2
46980 Paterna, Valencia

The International Year of Light and Light-based Technologies (IYL)

Silvia Braslavsky

Silvia.braslavsky@cec.mpg.de; braslavskys@me.com

This is a very partial report of several activities related to the International Year of Light (IYL) designated by the United Nations and UNESCO (<http://www.light2015.org/Home.html>).

► A prominent activity initiated by photochemists was the creation of the web page by Axel Griesbeck (presently Secretary of the Organic and Bioorganic Chemistry Division of IUPAC) and Michael W. Tausch in the site of the University of Wuppertal: <http://www.iyl2015.uni-wuppertal.de/>. Although this page is mostly in German focusing on its use by the German teaching and student communities, there are several parts in English and is a very entertaining and multitask web site, which has the support of the Specialized group on Photochemistry within the German Chemical Society. Several easy-to-perform experiments with and about light are described. In this page there is also a **list of events** celebrating the IYL in many Countries, including the “27th International Conference on Photochemistry” in Jeju Island, Korea, from June 28th to July 3rd, 2015.

► The Inauguration of the IYL took place in Paris, at the UNESCO Building on 19th -20th January 2015. I was invited by the Argentinian Physical Society to participate in the event, as a member of the Argentinian delegation (see photo below). Many activities, as well as the calendar of activities in many Countries can be found at: <http://www.light2015.org/Home.html>



Figure 1: From left: Eli Sirlin, an Argentinian Light Architect, Beatriz García, an Argentinian Astronomer and Silvia Braslavsky, before the replica of the “Camera Obscura”, as built by Alhazen 1000 years ago, and a statue of Alhazen.

► 2015 marks the 1000 years of the appearance of the 7-volumes treatise on Optics by Ibn al-Haytham, known in the West world as Alhazen, and his discovery of essential optical laws, such as the inversion of an image when the light reflected by the object passes through a pin-hole. His discoveries were honoured in Paris, among other things, with an extensive exhibition on the role played by Arab researchers in optics and related matters 1000 years ago. Extensive information is found at <http://www.light2015.org/Home/ScienceStories/1000-Years-of-Arabic-Optics.html>. The exhibition was prepared by the British association called 1001 Inventions (https://en.wikipedia.org/wiki/1001_Inventions).

► The “History of Light” and the discussions about its nature were also depicted in the exhibition. There is a beautiful video in youtube about this matter: <https://www.youtube.com/watch?v=OLCqaWaV6jA>

► Several initiatives related to the “Use of Light-based Technologies for Development”, stressing the use of LED’s and other affordable technologies were presented during the opening ceremony (<http://www.light2015.org/Home/LightForDevelopment.html>). Most of them extended during the year and beyond.

► 2015 marks also the Centenary of the Relativity Theory as enunciated by Einstein in 1915 and this was remarked several times during the 5 talks offered by Nobel Laureates during the opening ceremonies. They were: Ahmed Zewail (USA, Chemistry 1999), Steven Chu (USA, Physics, 1997), Zhores Alferov (URSS, Physics, 2000), William Phillips (USA, Physics, 1997), and Serge Haroche (France, Physics, 2012). The very entertaining talk by William Phillips can be found at:

<http://www.youtube.com/watch?v=DmBmegutsds>

► The question of the “Controlled use of Artificial Light” in order to be able to receive and monitor the Universe light (Cosmic rays) was posed by the Astronomers, i.e., “Dark-skies-Awareness” and “Avoidance of Light Pollution”. Several practical measures were suggested to be adopted to meet these goals:

<http://www.light2015.org/Home/CosmicLight/Dark-Skies>

Awareness.html. A price-affordable telescope (Galileoscope,

<http://www.optcorp.com/telescopes/refractor-telescopes/galileoscope-telescope-kit.html>) was presented during the exhibition at the inauguration ceremony.

► “Light and Art and Culture” was another question handled during the opening ceremony and beyond: <http://www.light2015.org/Home/LearnAboutLight/Art-and-Culture.html>. All forms of art and art-restoration with light-based technologies as well as light and architecture were discussed. There was an impressive exhibition of nature pictures and some holograms.

► “Light in Life” was another subject:

<http://www.light2015.org/Home/LearnAboutLight/Light-in-Life.html>. The health

related uses of light and the dangers of over-exposure to UV light, as well as the role of light in the sustainment of life (photosynthesis) and detection (vision) were the subject of presentations.

► An interesting discussion about “Scientific Policies” related to light and light-based technologies was held at the end of the two-days ceremonies with the participation of scientists from Africa, Latin America, Europe and the USA.

► I would like to mention the web page of the IYL as celebrated in Argentina: <http://2015luz.com.ar/>. Meetings, conferences, shows and exhibits about various aspects of the use of light have taken place. Activities for school-age children were presented in the whole Country as well as film exhibitions. The opening event in Argentina

was an open-skies laser-light show in January 2015 in Mar del Plata (a beach resort in the Province of Buenos Aires).

►The 2nd Graduate school called “Optoandina” takes place in Quito (Ecuador) from November 8th to 12th for PhD students (mostly physicists) from Latin America:

<http://optoandina.wix.com/optoandina2>. Within its frame I will be giving some lectures with general concepts of Photochemistry and Photobiology. The IYL is celebrated during the event.

A very large number of activities on the occasion of the International Year of Light and Light-based Technologies (IYL) have taken and are taking place in many Countries. These activities have surely contributed to create a deeper perception among the population about the controlled use of natural resources and the possibilities of new technologies as well as about general concepts in physical and natural sciences. A calender for each Country can be found by clicking the selected Country at <http://www.light2015.org/Home/About/Country.html>

It has been and still is an enlightning year.

The International Year of Light and Light-based Technologies 2015 in Down Under

Michael Oelgemöller

*James Cook University, College of Science, Technology and Engineering, Townsville, Queensland 4811, Australia. Email: michael.oelgemoeller@jcu.edu.au
<https://research.jcu.edu.au/portfolio/michael.oelgemoeller/>*

Special Issue of the Australian Journal of Chemistry – In celebration of the ‘**International Year of Light and Light-based Technologies (IYL 2015)**’ the *Australian Journal of Chemistry* published a dedicated special issue in November 2015.¹ The cover featured the IYL 2015 logo on top of a picture of Saunders Beach in North Queensland (Figure 1).

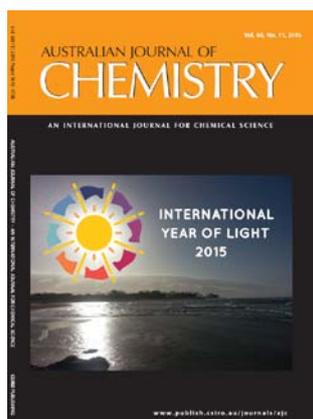


Figure 1. Front cover of the special issue.

Associate-Professor Michael Oelgemöller and Dr George Vamvounis from James Cook University (JCU) served as guest-editors. The special issue comprises 22 research articles that highlight recent achievements in photochemistry, spectroscopy and photophysics from across the world.

Norbert Hoffmann reviews TiO₂ photocatalysis in organic synthesis, whereas Eietsu Hasegawa and Shin-ya Takizawa summarize applications of 2-aryl-1,3-dimethylbenzimidazolines in photoinduced

electron-transfer reactions. In a follow-up research paper, Hasegawa and his group describe metal-free reductions of organohalides promoted by visible light using these materials. Solar brominations under continuous-flow conditions are reported by Chan Pil Park et al, while Shinichiro Fuse and co-workers realize the multistep Arndt-Eistert synthesis in a microreactor. Oelgemöller and his group describe photodecarboxylative benzylations, which are subsequently transferred to an advanced continuous-flow photoreactor system. Yasuharu Yoshimi et al generate carbanions through photodecarboxylations and trap these with benzaldehyde. Intramolecular cycloadditions are used by Andrei Kutateladze and his team for the construction of unusual molecular architectures, whereas Thorsten Bach and co-workers realize enantioselective rearrangements catalyzed by a chiral bifunctional xanthone. Tadashi Mori et al investigate diastereoselectivities of the Paternó-Büchi reaction of chiral cyanobenzoates. Abe and co-workers describe triplet and singlet cyclopentane-1,3-diyl diradicals generated photochemically, while Anna Gudmundsdottir and her team report on a non-conjugated triplet 1,2-biradical. Rosalie Hocking and colleagues study sodium birnessite-based films to improve solar fuel technology, whereas George Vamvounis et al utilize photochromic compounds as sensors for explosives detection. Florian Baur and Thomas Jüstel describe the phosphorescence efficiency of lanthanide-based red phosphors materials, whereas Ulrich Kynast and co-workers study solid-state luminescence of rare earth diclofenac complexes. Yuning Li and his team investigate charge transport in a diketopyrrolopyrrole-based polymer, while Tim Bender et al describe new light-absorbing aryl-substituted boron subphthalocyanines. Seth Rasmussen and co-workers report on light-absorbing thieno[3,4-b]pyrazine-fluorene copolymers, whereas David Lewis et al study fullerene content in polymers. The group of Kenneth Ghiggino describe a novel light absorbing copolymer based on benzodithiophene and [3,4-c]pyrrole-4,6-dione. Lastly, Hongxia Wang and colleagues report on perovskite solar cells based on nanocrystalline SnO₂.

The content of this special issue clearly reflects the multidisciplinary nature and importance of 'light' in the chemical and physical sciences.

Other contributions and activities – This year's internet portal 'Aktuelle Wochenschau (Current Weekly News)' of the German

Chemical Society (GDCh) is dedicated to the International Year of Light.² The portal publishes weekly outreach articles that highlight the importance of light in science and medicine to the public. Associate-Professor Michael Oelgemöller from JCU contributed two articles. The advantages of photochemical synthesis under flow conditions over batch processes are highlighted in Week 42. In the subsequent contribution in week 43, the same author summarizes the achievements of solar chemistry from the historic beginnings of photochemistry to modern solar manufacturing of fine chemicals. The importance of solar (photo)chemistry for the prevention, treatment and cure of insect-borne diseases is likewise highlighted in an earlier submission to the *EPA Newletters*.³

At the University of Melbourne in Victoria IYL 2015 was celebrated with an exhibition of lamps, spectroscopic instrumentation, and materials from the School of Chemistry's Cultural Collection that dates from the 1850's. The exhibit items were complemented with drawings by artist Peter Sharp. The Exhibition "*Illuminated: through the prism of chemistry*" was opened with a lecture by Dr Renee Beale, Curator of the collection, and Peter Sharp including a display of artwork projections on the exterior of the Chemistry Building.⁴ Likewise, photochemical and solar reactors were showcased at JCU's open day in Townsville in November (Figure 2). This exhibition was complemented by posters on ongoing photochemical research at JCU.



Figure 2. Chemistry stand at JCU's open day 2015 (with research posters in the background) and some of the photochemical gear shown.

Overall, the IYL 2015 has seen several activities in Down Under. These nicely represent the ongoing research activities in

photochemistry, spectroscopy and photophysics within the Australasian region.⁵

Acknowledgment – MO thanks emeritus Professor Curt Wentrup (editor-in-chief) of the Australian Journal of Chemistry for supporting the special issue.

References.

1. M. Oelgemöller, G. Vamvounis “International Year of Light and Light-Based Technologies” *Aust. J. Chem.* 2015, **68**: 1619-1620.
2. <http://www.aktuelle-wochenschau.de/main-navi/startseite.html> (accessed 19 November 2015).
3. M. Oelgemöller, M. Bolte, T. Goodine, S. Mumtaz, P. Malakar, A. Dunkerton, R. Hunter “The Eradicate Insect-borne Diseases with Sunlight Initiative at James Cook University in Australia” *EPA Newslett.* 2015, **88**: 85-90.
4. <http://www.chemistry.unimelb.edu.au/illuminated-stories-chemistry-cultural-collection> (accessed 19 November 2015).
5. (a) K. Ghiggino, M. Oelgemöller “Regional Focus – Photochemistry in Australia and New Zealand” *APA Newslett.* 2012, **2**: 17-21; (b) M. Oelgemöller, M. Bolte “Laboratory profile of the ‘Applied and Green Photochemistry Research Group’ at James Cook University in Australia” *Green Process. Synth.* 2014, **3**: 163-165.

International Year of Light 2015 Report on GDCh Activities

Michael W. Tausch,¹ Axel G. Griesbeck²

¹Chemistry and Chemistry Education, University of Wuppertal, Germany.

²Department of Chemistry, Cologne University, Organic Chemistry Institute, Germany

More Light!

„More Chemistry with Light! More Light in Chemistry!“ Under this title the editorial of the Special Issue of the GDCh-journal *Angew. Chem. Int. Ed.* (2015, 54, 11294-11295, see cover reproduced with permission of Wiley-VCH) GmbH & Co. KGaA.) concerning the International Year of Light has been published. Herein the author Thorsten Bach asks: „Why is chemistry overlooked when talking about light? Is the photon a physical particle per se? Are all important light-induced processes biological? And his answer is: „Maybe the role of light for chemistry and the role of chemistry for light may be far less important than a few eccentric scientists would like to believe. From the perspective of a synthetically oriented photochemist, however, the facts are different“.

Photochemical processes hold indeed key functions not only within demanding syntheses in organic chemistry but also in the conversion of solar radiation into storage of chemical energy following the role model of natural photosynthesis. This is even true for the photovoltaic conversion of light into electric energy and vice versa, namely the efficient conversion of electric energy into light as in LEDs and OLEDs. Photochemistry is involved in all these and many other processes, because the electronic excited state can be seen as a defined chemical species with totally different properties as the ones assigned to the ground state. Nick J. Turro already expressed this point of view in 1978: „The excited state is in fact an electronic



isomer of the ground state“and he also concluded „The ‚photo“ part of molecular photochemistry is a historical prefix and is now too restrictive. It is now clear that the electronically excited states of molecules are the heart of all photoprocesses.“

We chemists are well informed about the structure and properties of material entities, e.g. the molecules. And what do we know about the photons, the entities of light? Albert Einstein admitted a few decades after his Nobel Prize work of the annus mirabilis from 1905 about the photoelectric effect: „Zwanzig Jahre meines Lebens haben mich der Antwort auf die Frage ‚Was sind Lichtquanten‘ nicht näher gebracht. Heute bildet sich jeder Wicht ein, er kenne die Antwort. Doch da irrt er.“ (Twenty years of intensive thinking haven't brought me any closer to the answer of the question what a photon really is. Today every simpleton thinks he knows the answer, but they are mistaken.) It is known today that Albert Einstein had been speculating about the nature of photons (light quanta) without ever finding a definite meaning. Well, one is such a simpleton, if one goes into philosophical speculations about the nature of light quanta. However, as a pragmatic chemist one can tread on safe terrain by interpreting photons in the sense of Max Planck simply as the smallest packages of energy of electromagnetic radiation. Colloquially speaking it can be said, that photons assume the same role within the „zoo“ of radiations as atoms, ions and molecules do within the „zoo“ of matter, namely being the smallest portions or the smallest particles. Furthermore it can be added that certain photons can be absorbed or emitted by certain particles. This explanation would be really simplified but intelligible. With the basic concept of the ground and excited states all processes in which material entities and photons are involved can be described and explained in a at first simplified but scientifically consistent way. In that way the demand of „More Light! In Chemical Education Too!“ as found in the editorial of the editorial of the CHEMKON (4/2015), GDCh-journal of the Division Chemical Education, can be satisfied.

Go online!

Many exciting innovations and discoveries are made at the interface where chemistry meets the other sciences. This fact is undisputed and photochemistry offers many prototypical examples. Molecular switches, biological

imaging, organic light-emitting diodes, photodynamic therapy, functional dyes, photovoltaics: the keyword list for important interdisciplinary topics in photochemistry is long and keeps growing. In order to provide large information, the Gesellschaft Deutscher Chemiker (GDCh; German Chemical Society) has established are very well-produced websites related to the International Year of Light. For example, a project coordinated by Axel G. Griesbeck and Renate Hoer was collecting and publishing online each week in 2015 excellent contributions that cover all facets of the interaction between chemistry and light. This site can be found in a section called Aktuelle Wochenschau on www.aktuellewochenschau.de/mainnavi/startseite.

The GDCh-Divisions „Photochemistry“ and „Chemical Education“ have designed the website www.iyl2015.uni-wuppertal.de containing a large variety of information about conferences, symposia,



lectures and workshops during the year 2015 as well as a collection of Youtube videos from scientists working in the field of photochemistry and different teaching materials for photochemistry. It's worthy to emphasize the respectable number of experiments (more than 50), the two experimental boxes Photo-Mol and Organic Photo Electronics (see below) and the interactive animations simulating elementary processes with participation of light. Since the iyl-website indicated above is basically edited in German, we advise also www.chemiedidaktik.uni-wuppertal.de/ english that contains materials in English. These sources for online information will be available even after the end of 2015.

Photochemistry in Basic and Applied Research

Basic and Applied Photochemistry in a large variety is represented by scientific groups affiliated to GDCh-Division Photochemistry. Their research seeks for deeper understanding of photoprocesses as well as for new applications involving light. In 2015, more than 60 colleagues

from academia, industry and science education reported on their activities in these fields by easily readable contributions that are published online in the GDCh forum "Aktuelle Wochenschau". A collection of these contributions is given here (only the corresponding authors are listed here):

Contributions from chemistry education:

Renate Hoer, „Millions of light at the ACHEMA 2015 in Frankfurt”

Judith Rahner, „Organic Photovoltaics at the EXPO 2015 in Milano”

Michael Tausch, „Chemistry and Light: an imperative for education and teaching“

Claudia Bohrmann-Linde, „Liquid Crystals – experiments for teaching”

Amitabh Banerji, „OLED.Education”

Axel Griesbeck, „History of photochemistry”

Oliver Happel, „OLED-photometer for chemistry education”

Daily life phenomena:

Reinhard Zellner, „The earth atmosphere – a photochemical reactor”

Axel Griesbeck, „Blood analysis with chemoluminescence“

Axel Griesbeck, „Oxygen: Dr. Jekyll and Mr. Hyde”

Martina Neises-von Puttkammer, „Solar fuels from water and carbon dioxide”

Organic and Inorganic Photochemistry:

Burkhard König, „Organic synthesis with visible light”

Thorsten Bach, „Chirality and Light”

Horst Kisch, „Semiconductor as Photocatalysts”

Horst Hartmann, „Fluorescent organic nanoparticles”

Axel Griesbeck, „Photochemical protecting groups“

Karola Rück-Braun, „Photochromic organic molecules”

Michael Oelgemöller, „Solar Photochemistry”

Biological and Medicinal Chemistry:

Percy Lehmann, „Photodynamic Therapy“

Christoph Bräuchle, „High-resolution light microscopy for tumor therapy”

Kathrin Freudenberger, „Optical Sensors in medicinal diagnostics”

Physical Chemistry and Spectroscopy:

Peter Gilch, „Femtochemistry“

Christoph Haisch, Photoacoustic spectroscopy“

Dirk M. Guldi, „Singlet fission – make two out of one”

Maria Wächtler, „Following photoinduced catalysis with laser light”

Applied and Analytical Chemistry:

Gerhard Schlemmer, „Chemical analytics with light“
Axel Klein, „Photoinduced liberation of small molecules and radicals“
Michael Oelgemöller, “Flow Photochemistry”
Klaus Wendt, “Ultratrace analysis with laser light”
Thomas Oppenländer, “Sustainable detoxification of water”
Wolfgang Schnick, “White LED’s – High performance light sources”
Uwe Karst, “(Bio)imaging of elements by LA/ICP-MS”
Michael Schmidt, “Spectral and absolute calibration of light sources”
Alexander Kühne, “Switchable colored materials and future applications”
Wolfgang Buscher, “Plasma-spectroscopy, Part I and II”
Bernd Strehmel, “Light sources for lacquer chemistry: from UV to IR”
Claudia Weidenthaler, “Investigation of porous catalysts with light”
Contributions from industry:
Michael Dreja, „Can we enlighten our laundry?“
Brigitte Dicke, “Color: from vision to code numbers”
Heinz Mustroph, “Agfa and the beginning of industrial photography”
Adalbert Huber, “Effect pigments for optical effects in paints lacquers”
Thomas Fäcke, “Holographic photopolymers for diffractive optics application”

Further aspects of topical photochemistry and related areas (photobiology, photomedicine, spectroscopy and applied photosciences) were and will be covered also at symposia organized and sponsored by the GDCh such as the Wissenschaftsforum 2015 (WiFo) in Dresden, the regular scientific meetings of the photochemistry division of the GDCh (2014 in Cologne, and 2016 in Jena) as well as the Central European Conference on Photochemistry (CECP 2016 in Bad Hofgastein). During the WiFo2015 a session on synthetic organic photocatalysis was organized as a side-program to the plenary lecture of Stefan Hell, the 2014 Nobel laureate in Chemistry. Numerous lectures on all aspects of photochemistry and the educational aspects of photochemistry were also presented by the members of the Divisions of photochemistry and chemistry education of the GDCh.

Photoprocesses in Science Education

Due to the omnipresence of photoprocesses in nature and life as well as their large technical applications these phenomena nowadays count among the everyday experiences of everyone. Nevertheless they count also among the topics in scientific research at the highest level. Note for example that the Nobel Prizes in Physics and Chemistry 2014 have been awarded for the blue LEDs and for the STED-Nanoscopy.

It should be emphasized that from the educational point of view photoprocesses are par excellence suitable for teaching several basic concepts of chemistry, physics, biology, informatics, geography and further disciplines in close combination with everyday experiences and convincing applications from science and technology in the 21st century. Therefore research in chemical education is challenged to investigate and develop teaching materials for the inclusion of photoprocesses into science education. In this sense a couple of members and groups from the GDCh-Division Chemical Education are doing pioneering work in collaboration with the GDCh-Division Photochemistry.

The declaration of 2015 by UNESCO as “International Year of Light” pushed them once more to intensify their activities. The strategic focus of these activities is the investigation of experimental approaches for core concepts concerning first of all photoprocesses, but generally applicable in chemistry and related scientific disciplines. Common concepts for all chemical phenomena such as the relation between the structure of particle and the property of matter and donor-acceptor concept can be applied one-to-one for photochemical processes too. Other concepts, for example those regarding redox reactions, catalysis, kinetics, chemical equilibrium, and chromaticity have to be adjusted to the situation of the electronically excited state, the “heart of all photoprocesses”.

A series of novel experiments and teaching materials have been developed for investigating following photoprocesses: fluorescence and phosphorescence, electro- chemo- and electrochemoluminescence, photo-, solvato- and electrochromism, photovoltaics in inorganic, organic and hybrid cells, photocatalytic redox reactions in homogeneous and heterogeneous systems, photoisomerisations and photosteady states in solutions and in rigid matrices.

A considerable number of these experiments have been combined into two experimental boxes. The Photo-Mol box (photones and molecules) contains as light sources LED flash lights for white, violet, green and red light. The main chemicals are aesculin (for fluorescence and phosphorescence experiments) and spiropyrane. This is a veritable dream compound for teaching not only photo- and solvatochromism but also the basic differences between the thermal and photochemical reactions and also the difference between a thermodynamic equilibrium and a photosteady state. A central experiment in the Photo-Mol box is the preparation and investigation of an „intelligent foil“ with the molecular switch spiropyrane/merocyanine embedded in a solid matrix of polystyrene. The major part of the instruction book are 23 worksheets for



the interpretation and theoretical explanation of experimental observations at different teaching levels starting from the lowest level in chemical education up to the high school and even to the university level. The book and the USB stick contain, additionally to the worksheets, supplemental information about experiments, safety instructions, advice for the teacher and electronic materials, such as videos and model animations. Since July 2015 the Photo-Mol box is provided by the Hedinger Company Stuttgart. The English translation of the instruction book is still projected, nevertheless English materials are already available online via www.chemiedidaktik.uni-wuppertal.de/english.

The OPE box (organic photo electronics) contains equipment for assembling OLEDs and OPVs (organic photovoltaic cells). For this several quite expensive materials and chemicals are needed, i.e. conductive FTO (fluorine doped indium-tin-oxide) glass, galinstan (liquid alloy of gallium, indium and tin), „superyellow“ (a derivative of poly-para-vinylene-phenylene), P3HT (poly-3-hexyl-thiophene), PCBM (phenyl-C61-butyric acid methyl ester) and PEDOT:PSS (poly-ethylendioxythiophene, poly-styrenesulfonate). However, an ingenious and very cheap spin coater has been conceived. It is used for applying thin layers of photoactive materials on the FTO glass for both devices, for OLEDs as well as for OPVs. The OPE instruction book is designed similar to the Photo-Mol book discussed above. Up

to the end of 2015 it will be available in German and English. Nevertheless, the OPE box is not yet provided commercially, it is still in the testing and evaluating phase. Note, that very detailed online materials for assembling and investigating OLEDs and OPVs are already available for free in German, English and Spanish via the website above.

During
the



cited



2015

experiment called Photo-Blue-Bottle PBB simulating the natural cycle of photosynthesis and respiration has been rigorously improved for teaching purposes. It is now available in a microscale version operating with non-hazardous chemicals (nontoxic ethylviologen instead of toxic methylviologen) und low-priced light sources (LED flash lights). The light driven reduction of the substrate can now be realized in homogeneous solution with proflavine as photocatalyst as well as in a suspension with nano-TiO₂ (anatas). The conversion of light into chemical energy and storage in the reduced substrate until the reoxidation can be simply demonstrated in a concentration cell with irradiated and non-irradiated PBB solution or suspension respectively.



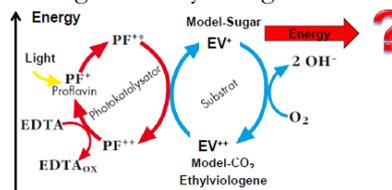
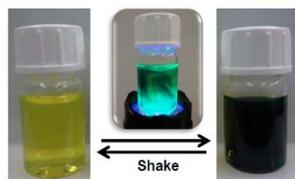
Details on the PBB experiment including theoretical background and advice for teaching photocatalysis are available online via www.chemiedidaktik.uni-wuppertal.de/english/index.html (see “Workshop” in Valencia and “Scientific Lecture” at SEADIM conference in Varadero, 2015). According to the actual topic in scientific research and development related to the age of CO₂ Capture and Conversion” the PBB experiment became additionally relevant as teaching



model for the endergonic and photocatalytic reduction of a substrate using sunlight as driving force.

Since several years we have been engaged in the transfer, communication and evaluation of teaching materials that involve photoprocesses to students, school teachers and academic lecturers. Encouraged by the Energiewende proclaimed in Germany we have been intensifying our efforts. Alone during the “International Year of Light 2015” more than fifteen experimental lectures, workshops and teacher training events have been given, for example in Frankfurt, Hannover, Berlin, Potsdam, Munich, Darmstadt, Wuppertal, Erfurt, Dresden, Aachen, Siegen, Rostock, Innsbruck, Havana, Varadero and Valencia. As expected, it has been found that the participants became highly motivated for dealing more and deeper with photoprocesses. This applies not only for people interested in chemistry, but also for those more oriented towards physics, biology, informatics and terrestrial atmosphere.

In the future educational programs and syllabi have to pay more importance to photoprocesses. Accordingly pretty experiments and the basic concept of the ground state and electronically excited states should be included and connected with the well-established concepts in the textbooks for teaching and learning chemistry in high schools



and universities. Doing so, we could essentially improve and accelerate the development of techniques for overcoming the “big five” global challenges of the 21st century related to the terms of energy, food, water, climate and mobility.

We like to acknowledge GDCh, DFG, FCI and Merck Darmstadt for supporting the investigation and the development of experiments and teaching materials discussed in this report.

Photo-Chemistry! Light, environmental monitoring and cancer fighting

A hands-on workshop for 11th grade high school students in the International Year of Light 2015

Guillermo Orellana

*Chemical Optosensors & Applied Photochemistry Group (GSOLFA),
Dpmt. of Organic Chemistry, Faculty of Chemistry, Complutense
University of Madrid (UCM), 28040 Madrid (Spain)*

On the occasion of the XVth Madrid Science Week (Nov. 2015), the UCM Chemical Optosensors & Applied Photochemistry Group (www.gsolfa.info/en) led by Prof. Orellana, organized a lively Workshop to teach junior high school students how light-induced chemical reactions (Photochemistry) is currently helping to improve our quality of life. Two areas that illustrate how photochemists have “domesticated” photons were addressed in three different hands-on experiments dealing with water quality monitoring (with luminescent chemical sensors) and cancer fighting (with photodynamic therapies). The Workshop was repeated for three days (Nov. 4-6), in ca. 2-hour sessions for 45 students per day within the organic chemistry laboratory. In each session, after a 10 min general introduction by the activity organizer, the students were divided into 3 groups, and two tutors (GSOLFA PhDs and postdocs) per group taught them the basics of each topic and helped them to carry out the planned experiments.

Dr. Maxi Bedoya and Guido Ielasi educated the attendees on how photochemical luminescent sensors based on optical fibres are used nowadays to monitor in situ, continuously and in real time, important water quality parameters such as the dissolved oxygen level. They showed the students how to manufacture a real sensor using an ordinary silicone sealant and a Ru(II)-polypyridyl indicator dye. After they prepared themselves such a sensor, the students tested the amazing red-orange luminescent O₂-sensitive films under the uv light before and after being hit with a focused nitrogen gas stream.

Dr. Victoria González de Vallejo and Idoia Urriza taught their pupils the applications of chemiluminescence to toxicity testing of natural waters and personal safety. Delivering to the students different

fluorescent dyes, they prepared awesome “light sticks” by mixing the dyes with diaryloxalates and hydrogen peroxide solutions.

Francesca Salis, José Angel de la Torre and Dr. Pramiti Hui illustrated the students the working principle of photodynamic therapies based on the reactivity of singlet molecular oxygen ($^1\text{O}_2$) to heal cancer and other diseases. Without using any real cell culture, the students discovered the effect of $^1\text{O}_2$ photosensitizing dyes on simulated tumours, upon violet diode laser or He-Cd laser excitation. Both students and tutors enjoyed three days of rewarding interaction to celebrate the IYL2015, wishing they had had more time to learn the thrilling applications of Photochemistry!



Workshop on Photochemistry (International Year of Light 2015)

María González Béjar

Instituto Ciencia Molecular, ICMOL/ Department of Organic Chemistry, Universitat de València, C/ Catedrático Jose Beltrán 2, 46980 Valencia, Spain, Email: maria.gonzalez@uv.es

Light-driven technologies are continuously emerging for applications that would offer new improvements to our quality of life. New photovoltaic devices, biomedical applications, fighting counterfeiting, and self-cleaning materials are just a few examples of the impact that light responsive materials can have in our lives.

In this context, it is a must to attract the attention of the general public and also students who will be part of the next generation involved in new discoveries based on light-matter interactions. Undoubtedly, the organization of outstanding activities on the occasion of the International Year of Light is an excellent opportunity to engage students and researchers in this topic. For this reason, the Photochemistry Reactivity Group¹, led by Prof Pérez-Prieto, hosted a Workshop on Photochemistry (Fig. 1). This highly pedagogical workshop was directed towards senior undergraduate and junior graduate students from chemistry, physics, engineering, and the life sciences. The workshop took place on October 14th, 2015 together with the celebration of the 17th Science Week at the University of Valencia. This was possible thanks to the outstanding and passionate contribution of Michael Tausch, Claudia Bohrmann-Linde and Amitabh Banerji from the University of Wuppertal, who have an excellent background in chemical education (mainly in the field of photochemistry) and also thanks to the organization and dissemination of the activities from the Scientific Culture and Innovation Unit Chair for Scientific Dissemination from the University of Valencia. The topics ranged from basics of photochemistry to conversion of electricity into light and *vice versa*.

The welcome and opening of the workshop by Prof Pilar Campins (Vice-rector for Research), Prof Isidro-Salvador Monzó Mansanet (*Dean of the Faculty of Chemistry*) and Prof Julia Pérez Prieto was followed by three interesting, didactic and communicative lectures during the morning session that included demos given by Prof Tausch and colleagues.²⁻⁴

After lunch, students were strongly encouraged to participate in three hands-on sessions designed by the University of Wuppertal team, alternating with another three experimental demos that included, for example, forensic chemistry and chemiluminescence experiments organized by Soranyel González Carrero and carried out by the University of Valencia team.

At the end of each session, the monologist Mariano Collantes talked about how we can communicate with bacteria using light and transgeneses.⁵

The excellent educational atmosphere created between the students and those giving the lectures and carrying out the demos was even better than we hoped for.

The workshop was held in English and enrolment was limited to 100 participants to ensure involvement in the hands-on experiments and keep the students' attention focussed on the topic. For those who already had some experience in photochemistry, the workshop improved their knowledge and techniques through lectures and hands-on training offered during the sessions. For those who were interested, but new to the topic, the workshop was an excellent opportunity to start them off in this field.

For more information about the workshop, please go to the website and Youtube video below.

<http://www.uv.es/uvweb/unitat-cultura-cientifica-innovacio-catedra-divulgacio-ciencia/es/unitat-cultura-cientifica-innovacio-catedra-divulgacio-ciencia/oberta-inscripcio-workshop-fotoquimica-1285898622434/Novetat.html?id=1285948568367>

<https://www.youtube.com/watch?v=dNJX59Opg-Y>

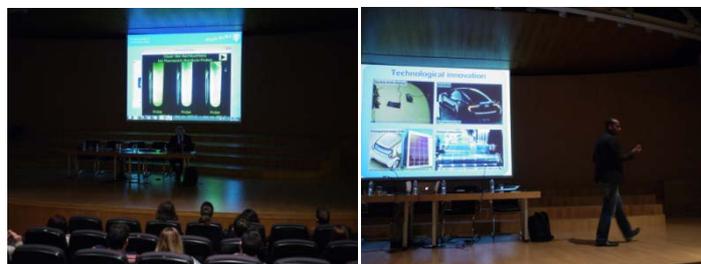


Figure 1. Flyer announcing the Workshop on Photochemistry at University of Valencia and two photos taken during the lectures.

Other activities – This year the *Institute for Molecular Science (ICMol)* of the *University of Valencia* is holding its 15th Scientific Conference dedicated to the International Year of Light with informative lectures on photochemistry on Friday December 11th. Three lectures will be given “Molecules and light: Applications in Materials Science and Medicine” by Prof Luisa De Cola from *Institut de Science et d'Ingénierie*

Supramoléculaires, Université de Strasbourg, who was awarded the binational Catalán Sabatier 2015 Prize by The Real Sociedad Española de Química; “Molecular solar cells based on perovskites: A real alternative to the silicon cells?” by Prof Khaja Nazeeruddin from *Ecole Polytechnique Federale de Lausanne*, and “Luz, química y vida” by Prof Miguel Ángel Miranda from *Instituto de Tecnología Química, CSIC/UPV*.

Remarkably, last May, The University of Valencia Science Park (PCUV) organized Expociencia (seventh edition), which is a relevant scientific activity, under the slogan “May science light you” to commemorate the International Year of Light.

Acknowledgment – The Photochemistry Reactivity Group thanks Michael Tausch, Claudia Bohrmann-Linde, and Amitabh Banerji from the University of Wuppertal and the Scientific Culture and Innovation Unit Chair for Scientific Dissemination from the University of Valencia, and the funding agencies that made the workshop possible.

References

1. <http://www.gruporeactividadfotoquimica.com>
2. Tausch, M. Basics of Photochemistry (2015).
3. Banerji, A. Conversion of Electricity into Light (2015)
4. Bohrmann-Linde, C. Conversion of Light into Electricity (2015).
5. <https://www.youtube.com/watch?v=YivrH4cSzC8>

The International Year of Light – a Personal and Professional Perspective

Malcolm D. E. Forbes, President, Inter-American Photochemical Society 2014–2016, Director, Center for Photochemical Sciences, Bowling Green State University, Bowling Green OH, 43403, forbesm@bgsu.edu

The 24th Winter Meeting of the Inter-American Photochemical Society took place in Sarasota, Florida January 1–4, 2015. This conference unofficially marked the first professional photochemistry event in UNESCO's International Year of Light (IYOL) and Light Technologies. Some of you may remember me lighting a candle at the meeting to make our "inaugural event" somewhat more official, and to commemorate the IYOL as a Society.

Our 2015 meeting, put together by co-organizers Sivaguru Jayaraman (North Dakota State University) and Clemens Burda (Case Western Reserve University) was a great success, with over 100 attendees and a very high quality scientific program in addition to some excellent weather, which was especially welcome at our new banquet site, *Tommy Bahama's*. The lecture sessions included presentations by many I-APS Award winners: There were two Gerhard L. Closs student travel awards (Elango Kumarasamy of North Dakota State University and Albert King of Ohio University). Josef Michl of the University of Colorado received the second ever Hammond award, Claudia Turro of the Ohio State University was the recipient of the 2014 I-APS Award in Photochemistry, and Joel Rosenthal (University of Delaware) was our 2014 I-APS Young Investigator. In addition, we inducted two I-APS Fellows: Richard Givens of the University of Kansas, and Frank Quina of the University of Sao Paulo, Brazil.

Throughout 2015, I experienced my own personal Year of Light, not only as current President of I-APS, but also as co-Chair (with Anna Gudmundsdottir of the University of Cincinnati) of the 2015 Gordon Research Conference on Photochemistry, which was held at Stonehill College in Easton, Massachusetts in July. This conference was attended by almost 150 scientists from across the globe and was also a great success. Most importantly, in July 2015 I made a professional move from the University of North Carolina at Chapel

Hill, where I had been a Chemistry faculty member for 25 years, to take the position of Director of the Center for Photochemical Sciences at Bowling Green State University in Ohio. My move has made 2015 an exciting year, full of transition and new momentum for my research group, my family, and myself. I am now very happily settled in northwest Ohio, running a vibrant Center that is a unique entity: the only institution in the world that offers a doctoral degree in the photosciences.

My most visible contribution to the IYOL is an *Outlook* I wrote for the newest journal from the American Chemical Society (ACS Central Science), entitled “What We Talk About When We Talk About Light.”¹ The paper, about which I have received many comments (not all of them complementary), is unconventional in that it attempts to provide a history of light from the first moments of the Big Bang up to the present day, and then pontificates about some interesting new research directions that I hope will stimulate young researchers in the field.

It was not easy to start with the Big Bang and arrive just a few pages later at technological advances such as the Edison light bulb and the laser. Early versions of the paper also included a more holistic view of light, detailing some of its roles in sociological anthropology (e.g., the gathering of early humanoids around campfires), politics (e.g., the first use of television in political debates in 1960), and religion (the use of stained glass and beeswax candles in Renaissance churches, and the activities of the sun worshippers of Stonehenge are notable examples) (Figure 1). It is probably fortunate that the wisdom of the editors prevailed as these musings were trimmed from what was supposed to be a scientific paper, but nonetheless they were interesting to think about.

In addition to technological marvels in light such as the Fresnel lens for lighthouses, the Nd:YAG laser for surgery, and most recently, the tremendous advances in resolution beyond the Abbe limit in optical microscopy, there are two major 20th Century thrusts in fundamental science that provided a detailed understanding of light in nature: the mechanisms of photosynthesis and vision. Through a Herculean effort by chemists, physicists, and biologists, the process of photosynthesis from the moment a photon hits the surface of a leaf to the production of a single molecule of ATP is now very clearly understood in terms of thermodynamics, reactive intermediates, and rate constants. There is still a way to go before we are able to



Figure 1. Light outside the scientific laboratory. Clockwise from top left: the first Kennedy–Nixon debate (September 26, 1960: note the contrast of Kennedy’s dark suit against the grey background compared to Nixon’s), a piece from artist Jan Tichy’s “Politics of Light” exhibition (2013), the map room from “Raiders of the Lost Ark (1981)”, Stonehenge at sunset (photo by Jake Rosen).

duplicate the necessary features for sustainable artificial photosynthesis, which is a major goal in current energy and agriculture research. A detailed molecular understanding of vision is also at hand, which has in turn led to interesting advances in brain function and memory. Electronic implants to provide visual ability for blind humans and other animals are now a reality, and represent an exciting step forward in this field.

This *Outlook* provided a platform to point out a few research areas that I thought would grow significantly in the next thirty years, to help guide younger scientists as they venture into independent research. My list of topics was by no means comprehensive – if a particularly exciting area was omitted, I am happy to learn of it. Remember that prediction is difficult, especially of the future!

So what is my opinion of that future? Societal issues such as management of energy resources, feeding a growing population, and protecting our planet’s fragile ecosystems are all high priorities that will demand a significant research effort to address. Finding thermal or photochemical pathways for the reduction of CO₂ to other reusable carbon feedstocks will not only contribute to alternative and cleaner energy technologies, but might also enable sequestration of

atmospheric CO₂ and, as hinted above, provide insight into methodologies for artificial photosynthesis to provide nutrients for humans as well as other plants and animals. Fluorescence microscopy and other biological imaging techniques will transform modern medicine, and I have already mentioned artificial vision, which will extend into neuroscience as we try to understand the role of the optic nerve and pattern recognition processes in the brain. The use of quantum dots and other more sophisticated nanostructured devices for medical, agricultural, and energy advances will continue to accelerate. A looming problem is phosphorus runoff from agricultural fertilizers which, in addition to accelerating depletion of the world's minable phosphorus supply, is now known as a major contributor to algae blooms (e.g. in Lake Erie in the U.S.) that can choke ecosystems almost completely and have proven to be harmful to humans in some cases. A method for returning phosphorus from lakes and oceans to useful fertilizer, perhaps using photochemical energy from the Sun, is a 21st Century "Holy Grail" in the field of agriculture.

I also used this paper to drive home a particular point about interfaces and how poorly understood they are from a molecular perspective. There is a great deal of room here for advancement and light can play a large role in this field. My criticism centers on the following comment: everything in the universe is interfaced in some fashion with everything else. But the types of interfaces that have been probed spectroscopy, and the variety of techniques used, has led to a scattering of data so large and seemingly divergent that what is learned from one study becomes almost impossible to generalize or to correlate with another. I likened the problem to the situation that existed in the field of electron transfer before Closs and Miller performed their systematic experiments on what we now call Donor–Spacer–Acceptor molecules.² This "physical organic chemistry" approach is exactly what the field of interfacial science needs in order to better understand, for example, bonding motifs of catalysts on semiconductors for solar fuels production. Optimization of the efficiencies of such devices will not be possible without such a detailed understanding.

The most interesting comments I have received about the paper were focused on my closing quote from Thomas Wolfe's *Look Homeward, Angel*, which many readers seemed unable to connect to the overall content. If you are curious, I encourage you to read the

paper and see if you can connect the dots to Wolfe's rather obtuse quote (hint: think in the abstract rather than the absolute). Please feel free to email me your thoughts!

In closing, I would like to extend an invitation to all of you to attend the 25th I-APS Meeting to be held in Santiago, Chile May 24–27, 2016 (Figure 2). After four previous conferences in South America, this marks the first time that our meeting will be held in Chile, and the organizers have put together a fantastic program in a beautiful location. I encourage you to join us there for what is sure to be a great meeting: <http://IAPS2016.ciq.uchile.cl>

25th I-APS Meeting
Santiago, Chile, May 24–27, 2016
<http://IAPS2016.ciq.uchile.cl>

Once again continuing the tradition initiated in the 1996 Iguacú Meeting in Brazil, the I-APS Conference is returning after 5 years to South America, this time to Santiago, Chile.

Invited Speakers

Tito Scalano (Ottawa)	Angel A. Martí (Rice)
Claudia Turro (Ohio State)	Dave Nicewicz (UNC–Chapel Hill)
Alexander Greer (CUNY)	Malcolm Forbes (BSGU)
Gerald Meyer (UNC–Chapel Hill)	Alexis Ostrowski (BGSU)
Santi Nonell (IQS)	Claudio Borsarelli (UNSE)
Marcelo Gehlen (USP)	Pedro Aramendia (UBA)
Guillermo Ferraudi (Notre Dame)	Rodrigo Palacios (UNRC)
Gonzalo Cosa (McGill)	Monica Gonzalez (UNLP)
Cornelia Bohne (Victoria)	Ezequiel Wolfan (UNLP)
Russell Schmehl (Tulane)	Andrés Thomas (UNLP)
Ana Moore (ASU)	Mauricio Baptista (USP)
Tom Moore (ASU)	Roberto Santana Da Silva (USP)
	Dave Whitten (New Mexico)

INTER-AMERICAN
PHOTOCHEMICAL SOCIETY

Figure 2. Advertisement for the 25th Inter–American Photochemical Society Meeting in Santiago, Chile in 2016.

References.

1. Malcolm D. E. Forbes, “What We Talk About When We Talk About Light,” *ACS Cent. Sci.* **2015**, *1*, 354–363, DOI: 10.1021/acscentsci.5b00261.

2. Closs, G. L.; Miller, J. R. "Intramolecular Long-Distance Electron Transfer in Organic Molecules." *Science* **1988**, *240*, 440–447.

The International Year of Light and Light-based Technologies 2015 in Italy

Alberto Credi

*Dipartimento di Chimica “G. Ciamician”, Università di Bologna, via Selmi 2, 40126 Bologna, Italy. Email: alberto.credi@unibo.it
<http://www.credi-group.it>*

Lots of initiatives, at various scales and levels, took place throughout Italy to celebrate YIL 2015. Of course, it would be impossible to mention all of them;¹ here we will briefly present the main events organized with the contribution or the involvement of the Italian Group of Photochemistry (<http://www.fotochimica.org>) and the Italian Chemical Society (<http://www.soc.chim.it>).

“Luci sullo stretto” (Lights on the strait). Messina, 30 March, 13 April and 20 April – This public event² was set up by the University and the City Council of Messina in cooperation with the Italian Group of Photochemistry. The role of light in several areas of science, technology, philosophy and religion was discussed in twelve conferences held by national experts. Overall, more than 2000 people attended the conferences during the three days.

Avogadro Colloquia “Chemistry and light”. Rome, 22 May – This one-day public symposium was organized by the Italian Chemical Society in the frame of the “Avogadro Colloquia” meetings.³ First-class researchers illustrated in conference and round tables the major challenges in the context of chemistry and light, with particular focus on a number of areas of application with remarkable societal impact, including medicine, energy, and environment.⁴ In consideration of the central role of Italy in world cultural heritage, the closing session was focused on the combination of chemistry and light for the enhancement and preservation of artistic masterpieces. At the end of the meeting, the participants had the chance to visit the beautiful Sistine Chapel, Vatican Museums, and enjoy the new LED-based lighting system.⁵

“Bologna s’illumina” (Bologna lights up). Bologna, 9-14 November – Several national and local institutions, including the University of Bologna, the National Institute for Astrophysics, the Italian Physical Society and the Italian Group of Photochemistry, in cooperation with

the Fondazione Marino Golinelli, organized one week full of meetings with scientific experts and VIPs, laboratories, exhibits and shows open to students of all ages as well as to the general public (Figures 1 and 2).⁶



Figure 1. *Bologna s'illumina*. Top: opening ceremony in the beautiful setting of the Archiginnasio Palace on 9 November. Bottom: Laboratory activities with primary school students at the Opificio Golinelli on 11 November.

The topics spanned from physics to biology and from astronomy to chemistry, also touching arts and social sciences. The program included a training course for teachers entitled “The thousand faces of light in astronomy, chemistry and physics”. Among the various shows, “The journey of Joe the Photon: a blues story” was particularly successful, while it is worth mentioning the laboratories about “Chemistry in colors”, “Playing with light: from visible to invisible”, “Light and the world of plants” and “Light and atoms”. Overall, more than 4000 people attended the various events of the initiative.



Figure 2. *Bologna s'illumina.* Left: light effects on the facade of the Santa Lucia Main Lecture Hall of the University of Bologna on 13 November. Right: musician and writer Roberto Vecchioni, physicist Luisa Cifarelli, photochemist Vincenzo Balzani and astrophysicist Fabrizio Bignami discuss about light, science and life with actor and showman Patrizio Roversi, in front of an audience of several hundreds people.

Other contributions and activities – In their essay⁷ opening the issue of *Angewandte Chemie International Edition* dedicated to the International Year of Light (n. 39, vol. 54, September 2015), Vincenzo Balzani, Giacomo Bergamini and Paola Ceroni pointed out that light is a very peculiar reactant and product in chemical processes. This important concept is commonplace for photochemists but it is certainly worth to be emphasized for the wider chemical community.

The following scientific conferences and schools dealing with chemistry and light took place in Italy in the frame of IYL 2015: *National School of Physical Chemistry "Energy production, storage and conversion"* (Otranto, 8-12 June),⁸ *Workshop "Chemistry, Materials and Light"* (Bologna, 21-23 September),⁹ *New Trends in Organic Synthesis* (Milan, 30 November),¹⁰ and the *Italian Photochemistry Meeting 2015* (Bologna, 17-19 December), which is the annual meeting of the Italian Group of Photochemistry.¹¹

Other events for the general public included the round table *‘Fiat Lux. Is a world without light possible?’* within the first world reunion of the University of Bologna Alumni (19-21 June)¹² and a series of conferences, shows, exhibits and laboratories entitled *‘La luce... come non l'avete mai vista’* (*Light... as you have never seen it*) organized in Parma by the City Council, the University and the National Research Council from October 2015 to January 2016.¹³

Such a plenty of initiatives for IYL 2015 in connection with Chemistry highlight the excellent health of Photochemical Sciences in Italy and reflect the intense scientific research and teaching activities going on in this area. The strong effort to make these events possible and the wide participation of the public are key to continue the long standing Italian tradition in Photochemistry¹⁴ established since the times of Emanuele Paternò and Giacomo Ciamician.

Acknowledgment – The author thanks all the members of the Italian Group of Photochemistry (GIF) and of the Photochemistry section of the Italian Chemical Society (GICh) for their invaluable contribution to the development, promotion and divulgation of Photochemical disciplines in Italy. INFN and Opificio Golinelli are gratefully acknowledged for providing the photographs.

References.

1. An exhaustive list of IYL2015 events in Italy is available at: <http://iyl2015.inaf.it> (Accessed 21 December 2015).
2. http://www.unime.it/__content/files/20150320114656invito_finale.pdf (accessed 21 December 2015).
3. https://www.soc.chim.it/it/news/avogadro_colloquia2015 (accessed 21 December 2015).
4. Chim. Ind. Web Magazine 2015, 2(10). https://www.soc.chim.it/sites/default/files/chimind/pdf/2015_10_3955_on.pdf (Accessed 21 December 2015).
5. <http://www.bbc.com/news/world-europe-29825898> (Accessed 21 December 2015).
6. <http://www.bo.infn.it/bolognasillumina/index.html> (Accessed 21 December 2015).
7. V. Balzani, G. Bergamini, P. Ceroni, *Angew. Chem. Int. Ed.* 2015, 54, 11320.
8. <http://conference.unisalento.it/ocs/index.php/nspc/nspc2015> (Accessed 21 December 2015).

9. <http://www.cml2015.it> (Accessed 21 December 2015).
10. <http://www.sintesi.unimi.it/index.html> (Accessed 21 December 2015).
11. <https://sites.google.com/site/gruppoitalianodifotochimica/congresso> (Accessed 21 December 2015).
12. <http://www.reunion.unibo.it> (Accessed 21 December 2015).
13. <http://eventi.unipr.it/luce/> (Accessed 21 December 2015).
14. A. Albini, *Photochemistry: Past, Present and Future*, Springer, New York, 2016.

New Trends in Photochemical Engineering and Technologies

Michael Oelgemöller^{1,*} and Karine Loubiere²

¹James Cook University, College of Science, Technology and Engineering, Townsville, Queensland 4811, Australia. Email: michael.oelgemoeller@jcu.edu.au

<https://research.jcu.edu.au/portfolio/michael.oelgemoeller/>

²Université de Toulouse, INPT, CNRS, Laboratoire de Génie Chimique (LGC UMR 5503), 4 allée Emile Monso, BP 84234, 31432 Toulouse, France.

In recognition of the 'International Year of Light and Light-based Technologies (IYL 2015)'¹ the journal *Chemical Engineering & Technology (CET)* published a dedicated special issue on 'New Trends in Photochemical Engineering and Technologies' in January 2016.² The cover features the IYL logo together with a spiral-shaped capillary microreactor developed by Loubiere and co-workers (Figure 1). The device allowed for *in-line* reaction monitoring by UV-Vis spectrophotometry and was used to study a photochromic reaction.



Figure 1. Front cover of the special issue of CET.

Associate-Professor Michael Oelgemöller from James Cook University and Dr Karine Loubiere from the Université de Toulouse served as guest-editors. The special issue comprises 5 review papers

and 13 research articles from across the world. The 18 contributions highlight new photoreactor systems and light sources, photoreactor modelling, photochemical methodologies and photoactive materials.

Strehmel et al. review digital imaging of lithographic materials by radical photopolymerization and photonic baking with NIR diode lasers. Lacombe and co-workers review reactors and materials used in gas-phase photooxidations for air treatment. Lomaev and colleagues present a review on excilamps and their applications in photochemistry. De Lasa describes photocatalytic efficiency evaluations using quantum yields and the photochemical thermodynamic efficiency factor. Rehm reviews photochemical fluorination reactions under continuous flow conditions. Oelgemöller et al. study photodecarboxylation reactions in an advanced continuous flow-reactor and furthermore apply it to the synthesis of a biological active target compound via a photo-thermal tandem process. Liu and collaborators develop a planar photocatalytic microreactor and assess its efficiency to degrade methylene blue. Li and co-workers utilize a microwave discharge electrodeless lamp in combination with H₂O₂ for the photooxidation of guaiacol to potentially valuable carboxylic acids. The group of Horikoshi develops solar-powered microwave discharge electrodeless lamps and utilizes them for continuous on-site field treatment of contaminated water. Deng uses computational fluid dynamics to assess radiation fields and disinfection efficiencies in UV reactors. Modelling and experiments in a spiral-shaped LED-driven microreactor are performed by Loubiere et al. to acquire kinetic data on a photochemical system. Ziegenbalg and his group study photon fluxes inside micro-structured photoreactors to demonstrate further optimization needs for these devices. Ponce-de-Leon and co-workers describe the construction of a photocatalytic flow reactor for the oxidation of methyl orange. Taghipour and Adeli report on the development of a GaN:ZnO-reduced graphene oxide composite for water splitting. Likewise, Fazaeli and colleagues design CdS and Ag/CdS nanoparticles for photocatalytic azo dye degradation. Hermosilla and collaborators describe the effects of carbonates on TiO₂-photocatalysis and photo-Fenton processes. Likewise, a commercially available TiO₂ photocatalyst doped with carbon is used by Ballari et al. for the degradation of acetaldehyde as an air pollutant.

Finally, Landgraf utilizes semiconductor light sources for time-resolved fluorescence HPLC detection.

Overall, the content of this special issue clearly demonstrates the importance of 'light' in applied photochemistry and photochemical engineering.

Acknowledgment – The authors thank Dr Elmar Zimmermann (deputy editor) and Dr Barbara Böck (editor in chief) of Chemical Engineering & Technologies for supporting this special issue.

References.

1. IYL 2015 homepage: <http://www.light2015.org/Home.html> (last accessed 29. December 2015)
2. M. Oelgemöller, C. Loubiere “New Trends in Photochemical Engineering and Technologies” *Chem. Eng. Technol.* **2016**, 39: 12.

PILLS OF HISTORY

At the origin of photochemistry. Leone Maurizio Padoa

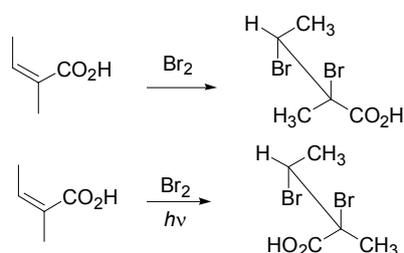
Maurizio D'Auria

Dipartimento di Scienze, Università della Basilicata, Viale dell'Ateneo Lucano 10, 85100 Potenza, Italy

Maurizio Leone Padoa was an assistant of Giacomo Ciamician. Usually, most of the photochemical work on photochemistry was performed by Ciamician with the help of Paul Silber, and we know all on this work. On the other hand, the photochemical work of Maurizio Padoa is completely forgot. He worked with Ciamician until 1920 when he was designated as extra professor at the University of Cagliari, and then he was nominated full professor at the University of Parma. In 1924 he returned in Bologna to maintain the chair of Industrial Chemistry. He continued to study the photochemical properties of some organic and inorganic compounds. During Fascism he had some problems. First, he signed the appeal of antifascist intellectuals promoted by Benedetto Croce. Then, he was suspended because his suspect on an assistant, a fascist assistant, and transferred to the University of Modena. In 1938, with the promulgation of race laws in Italy, being Padoa of Jewish religion, he was expelled from the University. In 1944 he was taken by fascist and nazist soldiers in his farm. He dead at Auschwitz.

Here we want to present an article he published on the *Gazzetta Chimica Italiana* in 1911, while it was an assistant of Ciamician. In this work we tested the possible use of circularly polarized light to induce a chiral reaction. He tested the reaction of angelic acid with bromine. The reaction mixture was completely different when the reaction was performed in the dark or in the presence of light.

The use of circularly polarized light did not give a chiral reaction. The result was in agreement with some other results obtained by for example by Cotton and can be explained on the basis of what we know on the mechanism of this reaction. For a discussion of CPL to induce a chiral reaction see Ref. 1.



Gazzetta Chimica Italiana **1911**, 41 (I), 469

Tentativo di sintesi asimmetrica con la luce polarizzata circolarmente

M. Padoa

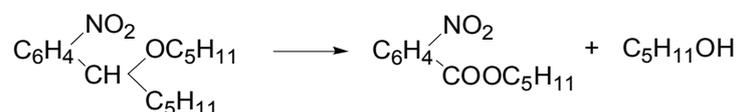
Il problema della origine naturale dei corpi otticamente attivi fu posto fin dai tempi di Pasteur. Questi pensava che per la formazione di un corpo otticamente attivo in una reazione, occorresse l'intervento di un'azione di *dissimmetria* che poteva essere anche fisica.

Le Bel e Van't Hoff suggerivano a tal uopo l'uso della luce polarizzata circolarmente fatta agire in modo da produrre corpi otticamente attivi.

La luce polarizzata circolarmente appare infatti come uno dei mezzi più frequenti di cui possa valersi la natura; secondo A. Byk ⁽¹⁾ essa, che si trova sempre commista alla luce ordinaria, deve certamente condurre al risultato desiderato. In questo senso fece dei tentativi Cotton ⁽²⁾, che dà anche un istruttivo resoconto dello stato attuale della questione.

Il Cotton tentava di rendere attive soluzioni di racemato di rame facendovi agire la luce polarizzata circolarmente e pensando che l'uno dei due componenti otticamente attivi venisse distrutto più rapidamente dell'altro – e ciò in corrispondenza del diverso potere assorbente degli antipodi ottici rispetto alla luce polarizzata destra e sinistra. Queste esperienze ebbero risultato negativo.

Freundler ⁽³⁾ pensò di far agire la luce polarizzata circolarmente sull'acetale amilico *r* dell'aldeide *o*-nitrobenzoica. Si forma, secondo la reazione di Ciamician e Silber, l'etere amilico dell'acido *o*-nitrobenzoico e dell'alcool amilico.



Ma nessuno dei due prodotti risultò otticamente attivo.

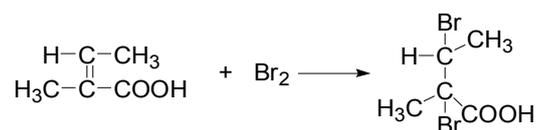
Henle e Haakh ⁽⁴⁾ partirono pure da due acidi contenenti atomi di carbonio asimmetrico:



Da questi, per azione della luce polarizzata circolarmente, eliminarono anidride carbonica utilizzando l'azione catalitica dei sali d'uranile. Ma non ottennero che corpi inattivi.

Io pensai che avrebbe avuto maggiore probabilità di successo un tentativo fatto utilizzando una reazione nella quale avvenisse la formazione dell'atomo di carbonio asimmetrico. Come tale mi si presentò la bromurazione dell'acido angelico. Dico subito che però anche il mio tentativo si risolse negativamente.

Wislicenus ⁽⁵⁾ ha trovato che facendo agire il bromo sull'acido angelico, in modo che quest'ultimo si trovi sempre in eccesso, si hanno risultati completamente diversi, secondo che si agisce al buio o alla luce.



Nel primo caso si forma quasi totalmente del dibromuro dell'acido angelico; nel secondo caso quasi esclusivamente il corrispondente derivato dell'acido tiglico. Così, in esperienze a luce diffusa in ambiente ben rischiarato, Wislicenus ottenne 11,26% del primo e 87,74 del secondo.

La formazione del derivato tiglico è dunque una reazione che risponde al requisito di essere determinata dalla luce: in essa si formano due atomi di carbonio asimmetrico. La reazione inoltre è più rapida delle altre citate, poiché con buona illuminazione può essere

condotta a termine in un paio d'ore; ciò diminuisce i pericoli della racemizzazione dei corpi attivi eventualmente formati.

PARTE SPERIMENTALE

L'acido angelico che mi occorreva lo estrassi da un olio di camomilla romana fornito dalla casa Schimmel e C. di Miltitz.

Dopo averlo saponificato con potassa a lieve calore, separai l'acido angelico dal tiglico, che era presente, in parte col metodo di Fittig⁽⁶⁾, basato sulla diversa solubilità dei sali di calcio dei due acidi, e in parte col metodo di Wislicenus (che consiste nel far congelare la miscela dei due acidi). Ottenni dell'acido angelico che si separò in grossi cristalli dall'etere di petrolio e fondeva esattamente a 45°, come indica Wislicenus.

Anzitutto eseguii una prova di bromurazione nelle condizioni indicate da Wislicenus per ottenere il bibromuro dell'acido tiglico. Gr. 0,04 di acido angelico sciolti in 2 ccm. di solfuro di carbonio vennero esposti alla luce solare, mantenendo fredda la soluzione con ghiaccio. Gr. 0,08 di bromo sciolti in 2 ccm. di solfuro di carbonio, vennero aggiunti gradualmente. A bromurazione terminata, la soluzione svaporata lasciò un corpo cristallino che fondeva a 75°. Il p.f. del bibromuro tiglico puro essendo 87,5°, si vede che la bromurazione aveva condotto, conforme ai dati di Wislicenus, ad una miscela di bibromuro dell'acido tiglico e di bibromuro dell'acido angelico, in cui il primo si trovava presente in quantità assai preponderante.

Verificai poi, esaminandone al polarimetro una soluzione al 10% in solfuro di carbonio, che l'acido angelico da me ottenuto non conteneva come impurità alcun corpo otticamente attivo.

Per eseguire l'esperienza di bromurazione alla luce polarizzata circolarmente, dovetti adottare una disposizione speciale, essendo necessario raffreddare con ghiaccio. La soluzione dell'acido angelico, gr. 0,35 in 5 ccm. di solfuro di carbonio, era contenuta in un piccolo palloncino; nel collo di questo passava un tubo proveniente da piccolo recipiente di vetro munito di robinetto, nel quale si trovava una soluzione di gr. 0,70 di bromo in 5 ccm. di solfuro di carbonio.

Il palloncino si trovava nell'interno di una scatoletta di legno; il tubo del recipiente superiore passava attraverso un tappo che intercettava completamente la luce; nel fianco della scatoletta, in faccia al palloncino, era praticato un foro, di fronte al quale era applicato un grosso nicol provvisto di una lamina di mica $\frac{1}{4}$ d'onda spostata di

45° in senso negativo rispetto alla diagonale minore del nicol. Tale disposizione permette di ottenere, per una data lunghezza d'onda, dei raggi polarizzati circolarmente, per le altre lunghezze d'onda raggi più o meno ellittici. Per raffreddare convenientemente la soluzione feci costruire una cassetta che ne conteneva un'altra sospesa nel suo interno; un largo tubo faceva comunicare la cassetta interna coll'esterno, ponendo in quest'ultima la scatoletta di legno sopradescritta, provvista di nicol. Il raffreddamento si otteneva riempiendo di ghiaccio e sale il vano fra le due cassette.

Dopo aver preparato tutto quanto e aver lasciato che il raffreddamento divenisse sufficiente si fece la bromurazione esponendo l'apparecchio alla luce solare. L'operazione ebbe la durata di ore 1 ½ circa. La soluzione venne subito svaporata per eliminare tracce di bromo non combinato; ridisciolto il prodotto in ccm. 7 circa di solfuro di carbonio, lo esaminai al polarimetro in un tubo lungo cm. 10. Ma entro i limiti degli errori d'osservazione, non potei osservare nessuna deviazione.

Cosicchè bisogna concludere che, anche in questo caso, la luce polarizzata circolarmente si manifesta inefficace allo scopo prefisso, oppure che la quantità di prodotto attivo formato è tanto minima da sfuggire all'osservazione, o ancora, che è avvenuta la racemizzazione.

1. Berichte, XXXVII, 4696
2. Journal de Ch. Phys., 1909, 81
3. Bull. Soc. Chim. Fr. 1907, 657.
4. Berichte, 1908, 4261.
5. Liebigs Ann. 272, 55.
6. Liebigs Ann. 283, 105.

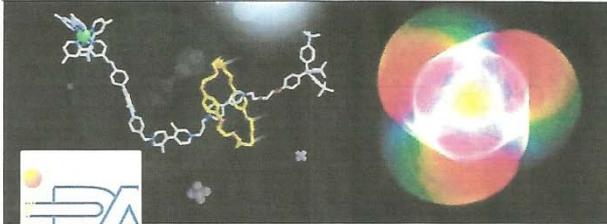
References

1. Rau, H. In *Chiral Photochemistry*, (Y. Inoue, V. Ramamurthy, Eds.) Marcel Dekker, New York, 2004, 1-44.

EPA IS ON FACEBOOK

6/2/2014 (3) European Photochemistry Association

Shirley D'Arcy



European Photochemistry Association
44 "Mi piace" • 4 no parlano

Mi piace Segui Messaggio

Organizzazione
European Photochemistry Association

Informazioni - Suggerisci una modifica

44

Foto Persone a cui piace Video

In evidenza

Pubblica

Invita i tuoi amici a cliccare su "Mi piace" su questa Pagina
Digita il nome di un contatto...

Invita Mostra tutti

Gianmarco Donati Invita

Alice Reccagni Invita

Jacopo Cerasani Invita

European Photochemistry Association ha condiviso un link.
1 febbraio

Job Optics and Nanospectroscopy
Germany

Home
www.wonton2015.org

The WONTON conference series focusses on advancing the understanding of photophysical properties and the spectroscopy of nanoscale systems with emphasis on carbon nanotubes and other nanocarbon materials.

Mi piace • Commenta • Condividi

European Photochemistry Association ha condiviso un link.
1 febbraio

Canadian Light Source / Centre Canadien de rayonnement synchrotron
www.lightsource.ca

The Canadian Light Source is committed to being a world-leading centre of excellence in synchrotron science and its applications by working with the scientific community to promote the use of synchrotron light, promoting...

Mi piace • Commenta • Condividi

European Photochemistry Association ha condiviso un link.
1 febbraio

Home
www.wonton2015.org

The WONTON conference series focusses on advancing the understanding of photophysical properties and the spectroscopy of

news: "Congress announcement:
First announcement of the 2015 International Workshop on Nanotube Optics and Nanospectroscopy (WONTON '15).
The workshop will take place from
1-4, June 2015
at Banz Abbey, a former Benedictine Monastery in upper Franconia, Germany.
Additional information on the workshop will be posted at
www.wonton2015.org.

Job Optics and Nanospectroscopy
Germany

Home
www.wonton2015.org

The WONTON conference series focusses on advancing the understanding of photophysical properties and the spectroscopy of

<https://www.facebook.com/pages/European-Photochemistry-Association/568823397987497?fref=ts>

1/2

join EPA on Facebook

ABSTRACT OF THESIS ON PHOTOCHEMISTRY

Synthesis, Photochemical Reaction Mechanisms of Formation, and Biological Activity of Benzene, Naphthalene and Anthracene Quinone Methides

Dani Škalamera

*Department of Organic Chemistry and Biochemistry, Ruđer Bošković Institute,
Zagreb, Croatia*

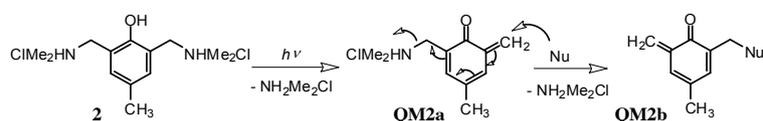
Ph.D. Thesis (in Croatian), 2015; Research Adviser: Nikola Basarić

This Thesis comprises synthesis and investigation of photochemical reactivity of three series of quinone methide (QM) precursors, which are derivatives of benzene, naphthalene and anthracene. The photoreactivity of compounds has been studied in solid state at 14 K for 2-hydroxymethylphenol (**1**), and in solution at room temperature for Mannich derivatives of *p*-cresol, naphthalene and anthracene derivatives. Mechanisms of photochemical reactions were studied in solution by preparative irradiations, by UV-vis and fluorescence spectroscopy and by laser flash photolysis (LFP).

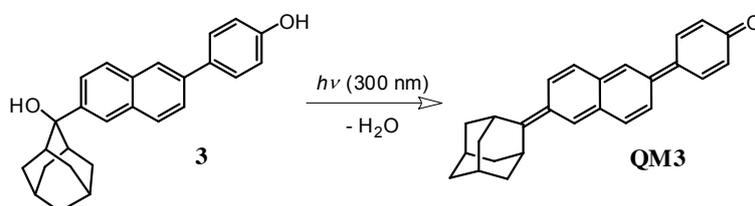
The photodehydration of compound **1** in solid state at 14 K gave a mixture of *o*-QM and benzoxete, which were detected by IR spectroscopy.



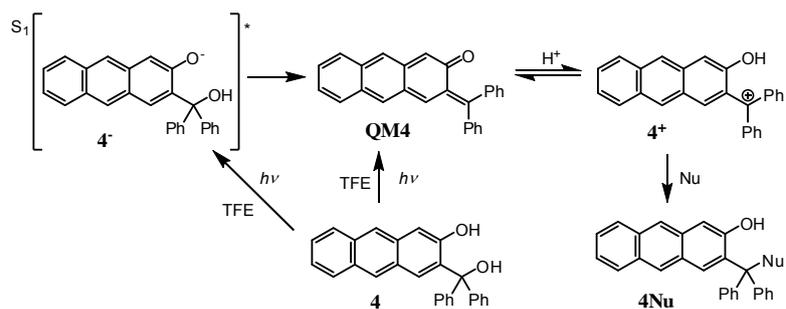
A mechanistic investigation of photodeamination in Mannich derivatives of *p*-cresol was conducted, demonstrating that the attack of nucleophiles to bifunctional **QM2a** generates new **QM2b**. This observation is of particular importance in the biological systems since it could be applied to DNA cross-linking.



Naphthalene derivatives were designed to investigate the optimal substitution pattern on the naphthalene chromophore for the most efficient photodehydration. Derivative **3** underwent the most efficient photodehydration to **QM3**, indicating that a 2,6-substitution is optimal.



Photogeneration of QMs from anthracenes is interesting because of potential application in biology, given that the chromophore absorbs at wavelengths >400 nm. Anthracene derivatives were prepared by a multistep synthetic procedure starting from 2-aminoanthraquinone. Formation of reactive intermediates from **4** was probed by LFP wherein **QM4** was detected. It was shown that **QM4** undergoes protonation to give the cation that subsequently reacts with nucleophiles.



Antiproliferative investigation on human cancer cell lines was conducted on several series of compounds with and without

exposure to irradiation. 3-Hydroxymethyl-2-anthrol (**5**) was found as a *lead molecule* which is not toxic without irradiation ($IC_{50} > 100$ mM), whereas irradiation significantly increased the antiproliferative activity (for HCT 116, human colon cancer cell line, IC_{50} is 1 ± 0.4 mM after 3×15 min of irradiation on 420 nm). The observed enhancement of antiproliferative activity upon irradiation can be correlated to the photochemical generation of reactive QMs.

Publication:

“Photosolvolysis of bulky (4-hydroxyphenyl)naphthalene derivatives” Đ. Škalamera, K. Mlinarić-Majerski, L. Uzelac, M. Kralj, P. Wan, N. Basarić, Photochem. Photobiol. Sci. 2013, 12, 2043-2056.

“Near-visible light generation of a quinone methide from 3-hydroxymethyl-2-anthrol” Đ. Škalamera, K. Mlinarić-Majerski, I. Martin-Kleiner, M. Kralj, P. Wan, N. Basarić, J. Org. Chem. 2014, 79, 4390-4397.

ANNOUNCEMENTS

CECP 2016 Conference Invitation

Stephan Landgraf
Institute PTC, Graz University of Technology, 8010 Graz,
Austria

From Sunday, February 14 to Thursday, February 18, 2016, photochemists from different countries will come together to share their results and experiences at the Congress Centre of Bad Hofgastein/Austria.

The scientific organization has been done by the international scientific committee: Michael **Tausch**, Wuppertal, D; Andrzej **Sobolewski**, Warsaw, PL, Petr **Klán**, Brno, CZ; Alexandre **Fürstenberg**, Geneva, CH, Sylvie **Lacombe**, Pau, F; Alberto **Credi**, Bologna, I. The conference will start on Sunday with the EPA come together including a buffet and an opening lecture.

6 plenary lectures are planned: Jacek **Waluk**, Warsaw, PL, "Various ways of looking at single molecules", Stefan **Hecht**, Berlin, D, "Designing photoswitches with improved performance", Natalie **Banerji**, Fribourg, CH, "Spectroscopic Investigations of Organic Electronic Materials", Paola **Ceroni**, Bologna, I, "Light-harvesting antennae based on luminescent silicon nanocrystals", Petr **Slavicek**, Prague, CZ, "Computational Photodynamics: From UV to X-ray domain", and Suzanne **Fery-Forgues**, Toulouse, F, "The Tao of solid-state fluorescent organic molecules: On the Way to luminescent microfibres and nanoparticles for biomedical imaging"

Deadlines are: Submission of short talk applications: December 1, 2015. Submission of poster applications: January 1, 2016. Registration: January 1, 2016, and travel grant applications: January 1, 2016.

Official web site of the meeting is www.cecp.at

26th IUPAC International Symposium on Photochemistry

Dear Colleague,

It is my great pleasure to inform you that XXVIth IUPAC Symposium on Photochemistry (2016 IUPAC Photochem) at Osaka City Central Public Hall, Osaka, Japan, on April 3 -8, 2016. On behalf of the organizing committee, we are delighted to invite you to this Symposium. I am sure that your participation and hearing of recent achievements would be a precious opportunity for the society members.

Date: April 3-8, 2016

Venue: Osaka City Central Public Hall, Osaka, Japan

Please kindly visit our official symposium website (<http://we.apollon.nta.co.jp/iupac2016>) for further information about 2016 IUPAC Photochem..

Please note that this invitation includes no offer of financial support.

I would be very pleased and honored if you could accept this invitation.

We are looking forward to a favorable reply from you soon.

Sincerely yours,

Tetsuro Majima

Chairperson, XXVIth IUPAC Symposium on Photochemistry (2016 IUPAC Photochem) at Osaka City Central Public Hall, Osaka, Japan, on April 3 - 8, 2016.

Secretariat for the 26th IUPAC

c/o West Japan MICE Sales Division, Nippon Travel Agency Co. LTD.

Osaka Ekimae No. 4 Bldg. 5F

1-11-4, Umeda, Kita-ku, Osaka, 530-0001 Japan

E-mail: iupac_2016@nta.co.jp

PHOTOCHEMICAL AND PHOTOBIOLOGICAL SCIENCES



Photochemical & Photobiological Sciences (PPS)

publishes high quality research on all aspects of

- photochemistry and photobiology, including elemental photochemical and photophysical processes
- the interaction of light with living systems
- environmental photochemistry and photobiology
- the use of light as a reagent
- how light affects health
- the use of light as a diagnostic tool and for curative purposes
- areas in which light is a cost-effective catalyst



With 96 days from manuscript receipt to advanced on-line publication, *PPS* is the fastest photoscience journal
Impact Factor 2.7

Submit your work today!

RSC Publishing



www.rsc.org/pps

MEMBERSHIP APPLICATION FORM



EUROPEAN PHOTOCHEMISTRY ASSOCIATION 2015 MEMBERSHIP RENEWAL/APPLICATION FORM

Please complete the form and send it to the Treasurer by mail or fax
(do not use e-mail for security reasons!):

Dr. Alexandre Fürstenberg
Department of Human Protein Sciences, University of Geneva
CMU, Rue Michel-Servet 1, 1211 Genève 4, Switzerland
(Fax +41 22 379 55 02)

I wish to renew/apply for membership of the European Photochemistry Association (EPA)

Family name: _____ First name: _____ Middle initial(s): _____

Date of birth (dd/mm/yyyy): _____

If you are applying for a new membership or if your contact details have changed, please fill in the following section:

Address: (Please use your institutional address)

Tel: _____ Fax: _____ Email: _____

Membership fees for 2015 in EUR (please check one box)

The membership fee includes electronic subscription to the EPA official journal
Photochemical & Photobiological Sciences, the EPA Newsletter and reduced conference fees.

	1 year	3 years	5 years
regular	<input type="checkbox"/> 35 EUR	<input type="checkbox"/> 100 EUR	<input type="checkbox"/> 150 EUR
student*	<input type="checkbox"/> 15 EUR * please supply attestation	<input type="checkbox"/> 30 EUR * please supply attestation	

For non-EU countries with economic difficulties, a reduced fee can exceptionally be applied on request (only upon written approval by the Treasurer).

Alternative methods of Payment (please fill in either 1. or 2.)

<p>1. Credit card. Please fill in the details below (all details compulsory).</p> <p>I, the undersigned, authorise the European Photochemistry Association to debit my credit card:</p> <p><input type="checkbox"/> MasterCard <input type="checkbox"/> Visa</p> <p>Card number _____ Expiry date: _____ For the sum of _____ EUR</p> <p>Amount of EUR in words: _____</p> <p>Name of card holder: _____ Signature of card holder: _____</p> <p>Security code: ___ (this code corresponds to the last three digits to the right on the back of your credit card)</p>
<p>2. Bank order to UBS AG, Roemerhofplatz 5, P.O. Box 38, CH-8030 Zürich, BIC (Swift): UBSWCHZH80A</p> <p>Account holder: European Photochemistry Association, c/o Dr. Alexandre Fürstenberg, 1211 Genève</p> <p>IBAN: CH27 0025 1251 8404 5260 C</p> <p>I herewith certify that I effected a bank transfer on _____ (fill in date) for the sum of _____ EUR</p> <p>to cover the EPA membership fee for the year(s) 2015 - _____ . Signature of the member: _____</p> <p>Please ensure that you are clearly identified on the bank order.</p>