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Steinkopff Award 1997 for Enrico Borgarello



Enrico Borgarello

The Kolloidgeellschaft award the Steinkopff Prize for special contributions to the application and transfer of interfacial and colloid chemical aspects to the technical practice and/or environmental problems. On the occasion of the 5th Wolfgang–Ostwald–Colloquium in Munich from 25 to 26 April 1997, Enrico Borgarello was awarded this prize. With this award, a colleague is honoured who already in the early years of his scientific career made great contributions to the application of the colloid chemistry in practice.

Enrico Borgarello was born in 1956 in Fusignano (Ravenna, Italy). He performed his studies in Torino, where he obtained his diploma in classical studies at the Liceo Classico V. Alfieri. Then he attended the University of Torino, studying Chemistry. In 1980 he obtained his Laurea in Chemistry, having worked with Prof. Ezio Pelizzetti at the University of Torino and Prof. Michael Graetzel at the Ecole Polytechnique Federale of Lausanne. The subject of the thesis was electron transfer reactions in micellar systems. He studied how colloidal systems, as micelles, could affect the kinetic of electron transfer reactions. The goal of the study was to find new strategies to obtain charge separation in electron transfer reactions in order to reduce the rate of charge recombi-

nation (back reaction). The major application was solar energy conversion, and in particular, the water-splitting reaction to obtain hydrogen from water.

His thesis was awarded by the National Academy of Science of Italy in 1981, with the Lorgna Prize given to him in Rome.

During his thesis in Lausanne, Enrico Borgarello started to study the use of colloidal dispersions of titanium dioxide for the photocatalytic water-splitting reaction. The colloidal titanium dioxide, when irradiated with UV light, produces electrons and holes, because of its semiconductor properties. These electrons and holes recombine very fast, but if they can be produced and stored long enough to be used for the reduction and oxidation of water, they can be a very simple and interesting way to store solar energy.

The work performed by Enrico Borgarello, after his thesis, at the Ecole Polytechnique Federale of Lausanne, was dedicated to find new and efficient strategies to store electrons and holes in photoexcited colloidal dispersions of titanium dioxide. This period was very intense and profitable: in 4 years he contributed more than 50 papers and few patents in this field. He learnt a lot and he collaborated intensively with major

research groups in this field. In particular, he collaborated with Prof. Pelizzetti at the University of Torino and Dr. Dany Meisel at Argonne National Laboratory in USA. In 1984 Enrico Borgarello went to Montreal, Concordia University to work with Prof. Nick Serpone. The aim of this collaboration was to start a group in photocatalysis in Concordia University and extend this field of research to other areas beside water splitting. On the basis of what Prof. Pelizzetti was doing in Torino, Enrico Borgarello and Prof. Nick Serpone, began studying photocatalysis for the degradation of PCB and chlorinated compounds which ended up as environmental pollution problems, especially in the pulp and paper industries. This research, performed in collaboration with Prof. Pelizzetti, ended with very interesting results, as these pollutants, when irradiated with UV light in the presence of a dispersion of titanium dioxide, were fully degraded to carbon dioxide and hydrochloric acid. The research on water-splitting reaction was actually abandoned by Enrico Borgarello to concentrate on the problem of environment. After the photodegradation of organic pollutants, he also studied the removal of toxic metals, as mercury, lead, zinc, cadmium from water using photocatalysis.

In 1986 Enrico Borgarello returned to Europe, to Lyon at the Ecole Centrale where he worked with Dr. Pichat in his group at CNRS. Dr. Pichat was interested in photodegradation of pollutants and this was a good opportunity for him to see a new research organization and contact new persons. The background of Dr. Pichat was in the area of catalysis. He then focused his interest on the identification of the mechanisms of photodegradation of organic pollutants on the surface of colloidal titanium dioxide.

In June 1986, Enrico Borgarello was offered a job in Eniricerche, the Corporate Research Center of ENI in

San Donato Milanese. He was hired as Senior Researcher in the Industrial Organic Synthesis Group, led by Dr. Platone. In those days, Dr. Platone has challenge from which came Eniricerche, to build a research group in colloid science. In fact, colloid science was recognized to be of great importance to the solution of many industrial problems in the ENI Group, but very little knowledge was present in the Company at that time. Enrico Borgarello was one of the researchers selected by Dr. Platone to organize the group. With the help of Prof. Stig Friberg, the group was built. Enrico Borgarello worked on several colloidal problems in the ENI Group of industries. At the beginning he was involved in surfactants, studying both the process of synthesis of new surfactants and characterizing their properties in specific fields of interest for Enichem Augusta Industriale, the operating company of the ENI Group involved in the synthesis of intermediates for detergents. Then he was involved in several projects in which colloid science played a major role: microemulsions for biomedical applications with Enichem Synthesis, dispersions (coal water slurries) with Snamprogetti and microemulsions for energy systems (addition of water in gasoil and gasoline to reduce the environmental impact of the fuel) with Agip Petroli. In several cases the results of the research were scaled up and brought to a pilot plant phase by the Operating Company involved.

In 1988, Enrico Borgarello became co-manager of the Industrial Organic Synthesis Group led by Dr. Platone. His role was to supervise the research activity of the group. At that time the Group was interested in the application of colloid science to solve problems in the Upstream industry, which is production and transportation of oil and gas. Enrico Borgarello was then deeply involved in Upstream projects with Agip on oil

and gas production, always focusing on colloidal problems.

In 1990 he was nominated Senior Scientist by the President of the ENI Group for his research activity in the area of colloid science. In the same year the Colloid Science Group was founded and he became Manager of that Group. At that time the Group was involved in several research fields in Upstream (production and transportation of oil and gas) with Agip, surfactants with Enichem Augusta Industriale, lubricants with Agip Petroli and materials for fuel cell with Snam. His major goal was to strengthen the colloidal background of his group and apply it to the solution of industrial problems. Now his group is recognized not only inside ENI, but worldwide mainly for the results obtained in the production and transportation of oil and gas.

The major scientific contribution of Enrico Borgarello is in the applied colloid science, developing new products and processes through the deep understanding of the colloidal phenomena which are responsible for the improvement. In a research field such as the production and transportation of oil and gas it is very difficult to simulate in the laboratory what really happens in a well. Each well behaves differently for its different history, for the specific lithology and for the way the well has been drilled, completed and produced. For Enrico Borgarello it was important to identify and reproduce, at the laboratory level, the phenomena occurring in a well and be able to control them. In the last six years his group under his leadership has gained a lot of experience in this context, being able to develop laboratory studies which have considerably improved the chemical and physical knowledge of the production of oil and gas.

Regarding the fluids, he with his group was able to find a new material which enhances the performance of high-temperatures operations and has

little impact on the environment. This was possible through the understanding of the basic mechanisms of the stabilization of dispersed clays in water when they interact with the formation in the real conditions of temperature and pressure.

Regarding the cementing of a well, he has developed a new colloidal additive which is able to prevent gas migration through a cement column, reducing the risk of a blow-out of the well. The new product was fabricated by the understanding of the chemistry and physics of the hydration reaction of a cement slurry in the real conditions of temperature and pressure of the well. In fact, by studying the mechanisms of nucleation and growth of the cement particles it was possible to identify defects and imperfections in the final cement. These imperfections are removed if the colloidal additive is added to the slurry: it interacts with the nuclei of the cement particles; filling all the imperfections and enhancing the seal to the casing. This product is now under commercialization.

A similar approach was used to find a new strategy for the treatment of asphaltene deposition in the well and in the tubing. Asphaltenes and waxes are a major problem in the production of oil and gas, as they can precipitate in the formation, causing severe reduction in the productivity of the well. The mechanisms of precipitation of asphaltenes and waxes from a crude are very complex and depend on the composition of the oil, the thermodynamic conditions of the well and the interfacial properties of the forma-

tion. Two different approaches were considered in the strategy: one to remove the deposition and the second to prevent the formation of asphaltenes or waxes. Both were possible by the knowledge of how asphaltenes form and grow in the well and on the surface facilities. With a very accurate study done in the bulk and in porous medium it was possible to design a very effective method of treatment which is now widely used by Agip.

For the water shut off during the production of oil and gas, he has developed a technology based on polymeric gels which are stable under very drastic conditions at high temperature and strong salinity. These gels are able to selectively reduce the permeability of water without affecting the oil productivity. Regarding sand consolidation in producing wells, he has developed a specific treatment based on the controlled polymerization of silicates in sand in order to strengthen the mechanical properties of the sand without reducing the gas permeability. This treatment allows the production of gas from wells that are producing sand, which are now abandoned because of the high cost of the treatment.

In the case of scale treatment and prevention it was necessary to understand the mechanism of scale formation and growth particularly under the well conditions. He has developed at the laboratory level an experimental setup in porous media which allowed to study the phenomena under conditions very close to the field. Particular attention was devoted to

the problem of heavy oil production and transportation. He has developed an innovative way to transport heavy oil by dispersing it in water with the help of proper dispersing agents. By understanding the mechanism of stabilization it is possible to disperse a wide range of heavy crudes. These results and others which are not reported here were made possible by the strong cooperation of his colleagues at Eniricerche, with the same commitment to colloid science and excellence and a great enthusiasm for research and science.

Enrico Borgarello is now Head of the Department of Colloid Science and Chemical Synthesis in Eniricerche. He is also member of the Board of Director of the Gruppo Interdivisionale of Colloid and Interfaces of the Italian Chemical Society. He is member of many organizations as Society for Petroleum Engineering, Italian Industrial Chemistry Division of the Italian Chemical Society and Italian Photochemistry Association. He has published more than 80 papers and is author of more than 20 patents. His responsibilities are now related to the management of the department with a strong commitment to excellence in scientific research and dedication to colloid science.

Enrico Borgarello is happily married to Germana Gallino and both have a very enthusiastic approach to everything they do, from everyday life to vacationing and outdoor life and friends and relatives. He likes skiing in winter and swimming in summer. He likes sports like tennis, volleyball and track and fields.