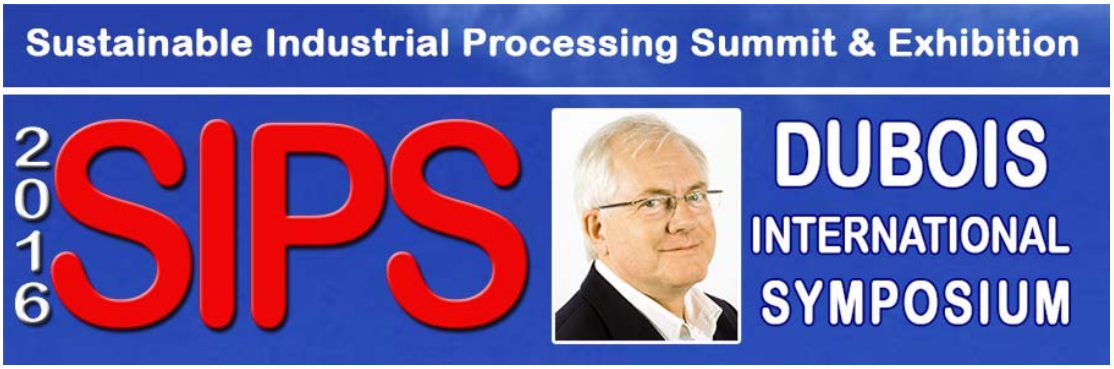

http://www.flogen.org/sips2016/dubois.php

Scientific biography of Jean-Marie Dubois

Director Emeritus of Research at Institute Jean Lamour, CNRS, Nancy, France, Scientific Adviser, Dpt of Nanostructured Materials, Jožef Stefan Institute, Ljubljana, Slovenia, and Professor at Jožef Stefan International Post-Graduate School.

The little town in the northeast of France where Jean-Marie Dubois was born in 1950 is known for having hosted for about a century one of the most advanced steel factories worldwide, which produced the bars the Eiffel tower of Paris is made from as well as many modern, top quality steels. This specific situation is probably what focused early Dubois' attention to metallurgy. It led him consider how sensitive this human activity is towards international competition and the absolute need to refresh it to avoid collapse, as it happened in this region of France, and elsewhere in developed countries. This is also why he tried his best to invent new metallic materials, to forge new applications of metal systems, and to accompany, sometime induce, the progress of basic knowledge in the area of metallic alloys. The systems he has studied range from metallic glasses, liquid alloys, and complex intermetallics to quasicrystals.

After graduating from a high school in Nancy, France, Dubois obtained an engineering degree in mechanical sciences in 1973 and a PhD in materials science in 1975. The '*Centre National de la Recherche Scientifique'* (CNRS), the largest research institution in Europe, hired him in 1977 as a permanent scientific staff member. He was awarded a (so-called in France) state doctorate in physics in 1981 and was a research scientist at the Cavendish Laboratory of Cambridge University, UK, during the period 1982-1984. Also an overseas fellow of Churchill College in Cambridge, this stay abroad offered him a fantastic opportunity to model the local structure of metallic glasses he had been studying during his doctor thesis, using Mössbauer spectroscopy, EXAFS, polarized neutron diffraction, and other more conventional techniques. His research topics evolved suddenly in the end of 1984 when Shechtman *et al*. announced in the Physical Review Letters the discovery of the first (metastable) quasicrystal. Few weeks later, in the same journal, a theoretical article predicted that "if real quasicrystalline materials exist (…), they are sure to possess a wealth of remarkable new structural and electronic properties".

This sentence had quite some resonance on Dubois' thinking. It changed his life deeply, and even more so when stable quasicrystals were pointed out, essentially by An Pang Tsai in Japan who could grow them through slow solidification of selected Al-based alloys. Complex aluminum compounds was a subject Dubois was working on from the beginning of the 80s, in search for a metallic glass essentially made of aluminum, which at that time had never been observed. Following theoretical ideas

grounded on his '*chemical twinning*' model, he found indeed few systems that could be made amorphous by fast cooling of the melt, from which a patent could be secured in 1982. This patent mentioned as exceptions to the range of easy glass formation, the compositions of alloys that turned out to be quasicrystals after Tsai's work. A selection patent was then issued in 1988 to secure specific quasicrystal compositions and their application to coating metallic substrates in view of producing cookware or other utensils. An intense period of activity followed then, split between understanding the structure and measuring the properties of these new materials, mostly using neutron diffraction, on the one hand, and on the other discovering the applied physics and usefulness of those new materials. As a consultant to an industrial company located some 600 km south to Nancy, he took part himself into the development of his inventions (frying pans, thermal barriers, low friction parts, …) and directed few programs financed by the French Government and the European Commission, including setting up the processing parameters of quasicrystal powder atomization and thermal plasma spraying of coatings made thereof. By the way, this is when he taught himself how to build up a significant research proposal and how to coordinate a broad range of research works.

Dubois' research topics evolved smoothly over the years, moving from high-dimensional modeling of the structure of quasicrystals, tiling and color symmetry of decagonal quasicrystals, atomic diffusion, icosahedral order in metallic melts, phase transitions from the liquid state and in the solid, electron transport and magnetic properties, heat conduction, to electronic structures, especially using soft X-ray emission spectroscopy together with Esther Belin-Ferré (Paris) who became his main collaborator and co-author for three decades. This work included a quest for new compounds with (preferably) giant unit cells that are abundant in Al-transition metal alloys, but also form in other types of systems. These so far unknown phases could be identified and characterized, combining neutron and X-ray diffraction, and transmission electron microscopy, and the atomic positions in few of them fully deciphered from experimental data. Those topics were perfect to trigger the curiosity and enhance the knowledge of many research students, PhDs and post-docs. Altogether, Dubois has supervised 30 thesis works (some in collaboration with his younger colleagues in Nancy) and 18 post-docs.

A turn in Dubois' career can be observed, in relation with the invention of the quasicrystal-coated frying pan mentioned above. Simultaneously, Dubois and one of his PhD students pointed out the relatively low friction behavior of quasicrystals against metallic counterparts. Such a behavior was in strong contrast to what is usually observed with metals. A number of basic studies, combining experiments in vacuum, modeling and correlations to electronic structure data, ended in a better understanding of the central role played in the physics of those materials by their unexpectedly low surface energy. Today, Dubois' research addresses a key point: why does Nature prefer to grow quasicrystals instead of periodic crystals with increasingly larger unit cells? His work is still far from being conclusive, but a number of experimental evidences focus to the importance of the localization of d-like electrons in competition to mobility of sp-states. The data are available to theorists who might like to address the problem.

Meanwhile, Dubois pursued a pretty fast career at CNRS. Promoted a director of research at the (young) age of 35, he was selected as a distinguished director of research (the ultimate degree in CNRS' hierarchy) at 54. He did quite some efforts to federate his scientific community, first by creating and leading the French research

initiative on quasicrystals that raised leadership in this fast-growing area in the 90s, then by uniting the materials science and engineering research laboratories in Nancy and finally by applying successfully to funding a European network of excellence dedicated to complex metallic alloys (CMA). On this later success story, he was twinning his efforts with those of Knut Urban and Louis Schlapbach, his German and Swiss, respectively, counterparts. Later on, Urban became the chairman of the German Physical Society. With two other German scientists, he is credited for the extraordinary breakthrough achieved in ultra-high resolution transmission electron microscopy, a work that already, and hopefully in near future, deserves him the highest international recognitions. Schlapbach, an expert in hydrogen storage, surface physics and electronic structures, moved from EPFL to take the head of EMPA, a pretty ancient and venerable large Swiss federal institution in charge of applied research, which he deeply reorganized and refocused on basic sciences.

During about a decade, Dubois coordinated the CMA network in Europe and established strong links with overseas scientists, especially in the US, Japan and China. His leadership in this field was recognized by the Robert F. Mehl award of the TMS and the establishment by Iowa State University of an international prize that carries his name and is allocated to anyone showing “excellence in a body of research concerning any aspect of quasicrystals, over the ten years preceding the award”. So far, Tsai in 2005 and four other professors from the universities of Zürich, Grenoble, Tel Aviv and Tokyo received this Dubois Award. More recognition was bestowed upon him, including three *doctor honoris causa* degrees and membership into two academies of the northeast of France (‘*Académie de Stanislas’* as correspondent and ‘*Académie Lorraine des Sciences’* as member of the mathematics, physics and chemistry section). Yet, the achievement he is the most proud of is his still-existing research team, which drastically evolved under the leadership of Vincent Fournée and switched few years ago to the application of ultra-high vacuum tools to surface studies of quasicrystals and complex intermetallics.

In his university of Nancy, France, Dubois was successively in charge of several research units of CNRS, which are listed in his curriculum. The most important one, almost in parallel with the CMA network, is his home institute that he created by merging five laboratories, which used to span a very broad range in materials science and engineering, from materials physics and chemistry to processing of alloys and surface engineering. This venture did not only address the rationale of the scientific programs dealt with in Nancy and a more performing organization of the research teams, but also the building of a modern institute with new and better facilities and equipment. With a total budget of more than 100 M€, the building is now almost ready. Yet, being arrived at the end of his mandate, Dubois left the project in 2012. He was then elected the chairman of one of the committees of ‘*Comité National de la Recherche Scientifique’*, focusing at the evaluation, recruitment and promotion of the scientific staff working in the area of solid-state chemistry, nanomaterials and processing. Apparently, he was the first metallurgist to be elected until now to such a position.

Sharp at the age of 65, and in accordance with the rule, Dubois retired from CNRS and was awarded the prestigious title of Emeritus director of research of CNRS. After serving French public research for 42 years, a new scientific life is now opening to him in Slovenia. Already an honorary member of the famous Jožef Stefan Institute (JSI) of Ljubljana, Slovenia, Dubois enjoys nowadays lecturing at the Jožef Stefan International Post-graduate School and collaborating as a scientific adviser of JSI on

high standard projects with Spomenka Kobe, the head of the Nanostructured Materials Department of this institute. Therefore, the next 42 years should prove exciting, fruitful and hopefully, healthy.

Co-organizers of the symposium:
- Florian Kongoli, chairman of SIPS.
- Spomenka Kobe, scientific adviser at Jožef Stefan Institute, head of Nanostructured Materials department, professor at Jožef Stefan International Post-Graduate School, Ljubljana, Slovenia. Jožef Stefan Institute, Jamova 39, SI-1000 Ljubljana, Slovenia. Spomenka.kobe@ijs.si
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