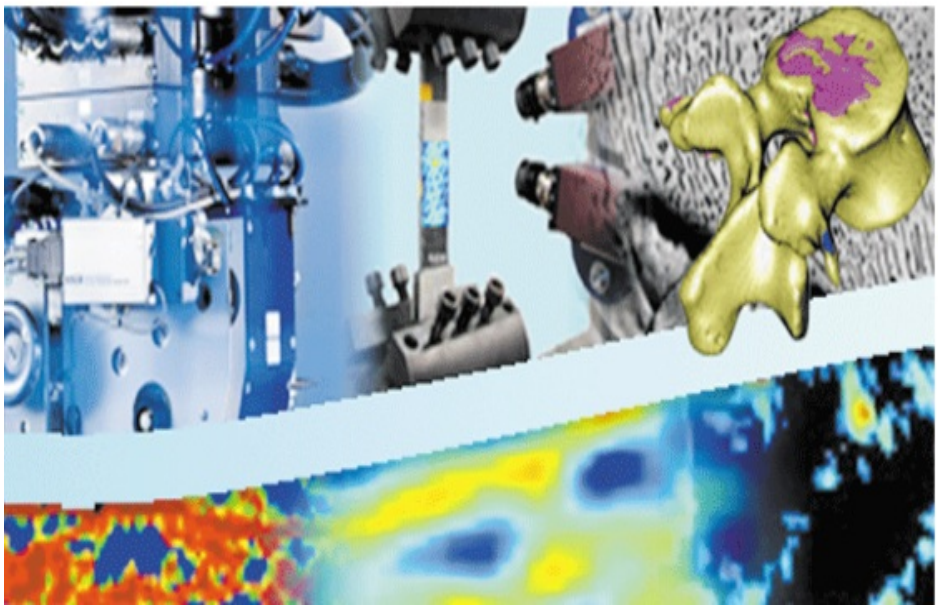
‘Interface’, key word of the ICACM 2016 conference

Focused as it is on the mechanical properties of innovative materials, the ICACM Conference brings together the world’s foremost specialists on the field, inter alia the role played by microstructures in material behaviour, at different scales. UTC, the University of Paris (P&Marie Curie) and the Sorbonne Universities Cluster co-organize this year the Franco-American ICACM Conference.

31 May 2016

ICACM 2016



The world of materials today is undergoing continuous innovation, witness the advent of electricity conducting plastics, ultra-resistant coatings that make metals almost rust-proof or nanometric-scaled composites with optimised resistance and lower mass. And if the experts still use real experimentation, we can observe an ever-growing presence of digital tools.

For this 9th edition of the conference, the International Center for Applied Computational Mechanics (ICACM) has decided to focus its attention preferentially on materials and in particular on the role of microstructures in material behaviour at different scales, including the macroscopic level. “By studying material behaviour at differing scales we hope to understand the physical mechanisms that apply at these levels and their impact on macroscopic material behaviour”, details Salima Bouvier, Director of Mechanical Engineering Department at UTC who heads the Materials and Surfaces research team and who is co-organizer of ICACM 2016.

From micro to macro-scaled research

The main questions revolve round the ways and means to identify

relevant scales at which data can be collected and used to model certain phenomena. The specialists also focus on the mathematical computational tools available so as to be able to describe these physical phenomena at a relevant scale. “Architectures and microstructures are becoming increasing complex today” underline Salima Bouvier, who also notes that “the classic tools used to characterize material behaviours are inadequate”.

The scales investigated run from the nano-metre (10-9m) to the centimetre (10-2m) and the research scientists are working on the development of digital tools capable of integrating the complexity of the microstructures while ensuring the precision and efficiency of the computations. The objective is to be as close as possible to the physical reality of materials and to quantify “imperfections” of the real materials, their heterogeneity. By way of an example, a flaw often leads to a catastrophic material break. It is therefore important to be able to statistically describe the events observed: this is done using fine scale probabilistic descriptions for material flaws.

Modelling used to improve experimentation

The relationships between digital modelling and experimentation are changing today. Formerly, experimental results were used to assess or even correct digital models – today the same models are used to complete the date and results obtained in real experiments. The exchanges between experiments and digital computations facilitate our understanding of those mechanisms that operate when the materials are in use.

“For example, when designing rosin impregnated stitched carbon fibre composite structures, the models can reveal certain anomalies at the stitch borders”, explains Salima Bouvier who suggests that the test protocols could be focused on these specific points. A concept known as “test-computations” will be addressed in several papers presented at the Conference.

Describing matter in terms of its volume …

One of the new challenges - in terms of decription and characterization of material behaviours – is to be able to access volume-related information. Until recently, the experimental approaches enabled descriptions of material surface behaviour. “Today we have measurement protocols and tools to explore the surface behaviour of materials, but the question remained: how to explore the materials in depth, using non-destructive testing”, underlines Salima Bouvier.

The question, she adds, is how to extrapolate a surface information to the rest of the material under the surface. With the progress noted in tomography and other volume-related forms of investigation coming on line, it is now possible to explore damage zones through a given material sample. These new techniques offer a rich harvest of experimental information and lead to validating the corresponding mathematical models. Inn like manner, to take into account the real architecture of materials in the modelling software, we now have tools that enable the scientists to build 3D models of the material architecture by aggregating a series of slice-cut images. These tools are continuously being improved.

… and controlling the interfaces

What is “interface”? Undoubtedly yet another key word for ICACM 2016! The interface designates the contact area between two material surfaces. For example, it is the zone that separates a metal alloy from its coating, or the contact area between the fibres of a composite material and its matrix, where the forces between the fibres and the matrix are exerted. It therefore is a very thin element which does not lend itself readily to experimental measurements, not because the tools do not allow us to reach such a small-scale zone but the results can be ‘flawed’ by the two materials on either side of the contact zone.

A second difficulty resides in the fact that the interface is a highly complex area in terms of its architecture and specific properties. It remains true, nonetheless, that gaining knowledge of the interfaces is of prime importance since often they are relatively weak parts of the structures. To illustrate this, we occasionally see paint scaling, premature cracking of material, certain forms of corrosion … If we can get to better understand these properties, we shall learn more about the potential weak spots and then take adequate compensatory steps to correct this.

The ICACM 2016 Conference, organized by the UTC Roberval Laboratory, is financed partly by the UTC Labex Programme inasmuch as it integrates variability and indeterminate factors to a specification of the materials behaviour under investigation. One half-day session is devoted to probabilistic and stochastic approaches useful in material behaviour description.

ICACM, from inception to today

ICACM began in 2005, following suit to a meeting between Oana Cazacu, who at the time was a research scientist at the University of Lille –France and John “Row” Rogacki, who was a research scientist to, at the Research and Engineering Education Facility (REEF) of the University of Florida. “We worked together at the REEF given that computational mechanics was an area of high interest for the Air Force Base at Eglin where they were conducting research assignments into conventional weaponry”, notes John «Row” Rogacki. Following that the two specialists built up their Franco-US relationship developing a collaborative network thanks to the organization of a thematic conference. “A number of French and American universities were approached to participate and, given the interest expressed, a Franco-US organisation team was set in motion to convene the first conference at the REEF in 2007”, details Dr. Rogacki.

If, originally, the ICACM Conference was a Franco-US initiative, it is because of the strong involvement of these two countries in the

field of digital computation. “Numerous famous French origin mathematicians laid the bases of this specialty”, notes the American researcher. But one must not forget the major American research work carried out that served to structure the specialty and the strong scientific links that now exist between the two countries, facilitating the organization of joint work programmes.

Today, John "Row" Rogacki is now Deputy Director of the IHMC (Institute for Human and Machine Cognition), Florida. He is no longer personally involved in organizing the ICACM Conference but continues to support it by supervising the contents and helping to securing financial support in the USA. The 9th ICAM Conference, June 1-3, 2016 will be co-organized by UTC and the University of Paris 6 (Pierre & Marie Curie), making it a Sorbonne Universities Cluster event, partly financed by the COMUE.