

EUROMECH Colloquium 577
“Micromechanics of metal ceramic composites”

30 March – 2 April, 2015, Lucca, Italy

Chairperson: Prof. Marco Paggi
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Background

Metal ceramic composites are applied in different fields, including: nuclear energy, aerospace, prime mover development and energy conversion. The mechanical behaviour of composites is evaluated on both microscopic and macroscopic scales to take into account inhomogeneities, including cracks, and interactions between inhomogeneities.

Participation

EUROMECH Colloquium 577 concentrated on new ideas and innovations in modelling of different types of metal ceramic composites as well as on fracture of composites. The Colloquium was held at the University of Stuttgart and included a guided visit to the Mercedes Benz Museum. The main organiser was the Institute for Materials Testing, Materials Science and Strength of Materials (IMWF). 46 scientists from European and non-European countries participated in the Colloquium: 17 from the host country Germany; 8 from Russia; 21 from other countries, including Canada, Japan and USA. This worldwide representation demonstrated the international relevance of the Colloquium.

Colloquium Topics

The various contributions showed a good combination of theoretical, analytical and numerical modelling on different length scales, and experimental work. There were many opportunities for participants to exchange ideas. The Colloquium focussed on the following aspects of metal ceramic composites including functionally graded materials:

- Modelling of thermal and elastic properties from a practical point of view and of the applicability to specific problems, such as failure analysis;
- Micromechanisms of deformation and microstructural fracture aspects;
- Atomistic studies on deformation and fracture;
- Mathematical and computational modelling of cracks;
- Layered metal-ceramic composite materials, multilayer graded structures and graded interfaces.

State of the art lectures were presented by internationally known experts. The plenary lectures were delivered by Helmut J. Böhm (TU Wien, Austria), Javier LLorca (TU Madrid, Spain) Wolfgang H. Müller (TU Berlin, Germany), and keynote lectures by Georges Cailletaud (MINES Paristech, France), Pedro Ponte Castañeda (University of Pennsylvania, USA), Sergei Mikhailov (Brunel University, UK), Sergey Panin (SB RAS, Tomsk, Russia), Viggo Tvergaard (TU Denmark), and Patrizia Trovalusci (Sapienza University of Rome, Italy). There were 42 presentations in total. Talks were organized in the following sections:

- Processing, experiments;
- Micromechanics of deformation and fracture;
- Functionally graded materials;
- Fracture and failure;
- Bio/nanomaterials.

Various constitutive models were presented for particle-reinforced composites. A statistical approach for micro-scale modelling of metal ceramic composites was also presented for several specific types of composite microstructure.

There was a particular focus on composites where void growth in the metals is affected by the presence of a ceramic phase. Metal-ceramic layered composites were considered for nano-laminates. The contribution was focused in the analysis of the deformation and failure mechanisms of a model Al/SiC metal-ceramic nanolaminate by means of a combination of nanomechanical experiments and simulations. Metal-ceramic nanolaminates were found to show a dramatic increase in strength as compared to standard metal-ceramic nanocomposites. Several presentations were devoted to functionally graded materials (FGMs), a special type of composite.

Modelling was carried out on nano, meso and macro length scales. Advanced techniques for modelling of composites, such as X-FEM, coupling molecular dynamics and FE, cohesive finite element methods, as well as hierarchical FE models have been used. A wide range of metal ceramic composites was investigated, including bio-inspired materials.

Concluding Remarks

The response from participants with respect to the organisation of Colloquium 577 was very positive. The scientific programme was quite intensive, but there was also time for discussions during coffee breaks and meals. Financial support was provided by EUROMECH, SimTech, SFB-716 and DFG. The participants took advantage of opportunities to discuss problems, establish new trends and consider possibilities for future scientific cooperation. Selected papers will be published in a special issue of "Computational Materials Science".