

Report on the activities of the WP- 4 on Materials processing

The members of this WP are René Moreau (France, metals and semiconductors), Shigeo Asai (Japan, metals), Robert M. MacMeeking (USA, ceramics) and Charles L Tucker III (USA, polymers).

This working party covers four main classes of materials: metals, semi-conductors, ceramics and polymers. In each field, the scientific activity is very impressive and the number of conferences and less formal seminars or colloquia is important. It is also noticeable that nowadays the approach is completely multidisciplinary, so that specialists of materials sciences interact often and deeply with specialists of fluid or solid mechanics. This is a general trend since at least one decade, but in the field of this WP, it is also a consequence of the development of numerical techniques, which make easier than before the integration of knowledge coming from different disciplines into a unique model. One should also notice that international programs oriented towards applications (for instance, in Europe, the Microgravity Application Programs, supported by ESA) play a significant role in establishing networks between complementary research groups and industries. It seems this is a kind of irreversible process which will continue during the coming years.

To be more specific, in the domain of metals and semiconductors, there were a number of important international meetings during the year 2003 where the attendance of scientists coming from the fields of fluid and solid mechanics was quite significant. Let us mention:

- Electromagnetic Processing of Materials 2003, Lyon, France, 14-17 Oct. 2003;
- International workshop on use of magnetic fields in crystal growth, Riga, Latvia, 5-6 Dec. 2003;
- as well as the annual symposium of the European Society of Material Sciences in Strasbourg.

Let us also mention two important meetings scheduled for 2004:

- International Summer School on Crystal growth, Berlin, 2-6 August 2004,
- International Congress on Crystal Growth, to be held in Grenoble, 9-14 August 2004.

The polymer processing area is rich in theoretical and applied mechanics content. Topics such as simulation of non-Newtonian fluid flow, theoretical and applied rheology, and the modeling of structure development during crystallization present significant challenges and research opportunities for mechanicians. Research in polymer processing has traditionally centered on continuum mechanics, its relation to polymer physics, and on numerical simulation methods. However, in recent years other aspects of mechanics have begun to have an impact on the area. For instance, nonlinear dynamics is becoming an important tool for analyzing polymer mixing operations, which are now known to be an important application of chaotic advection. Technical meetings and workshops on polymer processing are sponsored by a number of groups worldwide. Some of these are societies that are dedicated to the subject: The Society of Rheology, the European Society of Rheology, the Japanese Society of Rheology, and the Polymer Processing Society. A few, less-formal groups sponsor important meetings, e.g. the Workshop on Numerical Methods in Non-

Newtonian Flow, and the Gordon Research Conference on Polymer Processing. Finally, polymer processing sessions and symposia, and opportunities to discuss polymer processing research in a broader setting, are provided by societies such as ASME, AIChE, and IUPAC, as well as IUTAM.

Ceramics processing presents many opportunities for work in theoretical and applied mechanics and this field is very active. The production and handling of green bodies provides many challenges to those working in the areas of mixing, rheology, viscoplasticity and shape forming. In sintering, problems related to stress coupled mass transport, viscoelasticity, microstructural evolution and high temperature plastic deformation have been tackled with a theoretical and applied mechanics approach. In addition, production methods such as machining and net shape forming have recently commanded the attention of researchers in the theoretical and applied mechanics field. Thus, the area of ceramics processing in connection with theoretical and applied mechanics is very active in terms meetings and workshops. The theoretical and applied mechanics of the subject is addressed regularly in symposia and conference sessions in the meetings around the world of groups and societies primarily concerned with mechanics, such as the IUTAM itself, EUROMECH, the ASME Applied Mechanics Division, JSME, GAMM and other national organizations. In addition to these activities, organizations with a primary focus on materials science also mount symposia and conference sessions that contain a significant amount of theoretical and applied mechanics addressed towards ceramic processing. These groups include the American Ceramic Society, the European Ceramic Society and the Japanese Ceramic Society plus broadly based organizations such as the Materials Research Society. The wide variety of fora available for theoretical and applied mechanics research in ceramic processing promotes breadth and relevance in the field and ensures effective multidisciplinary approaches. Thus the ceramics area of materials processing in regard to theoretical and applied mechanics has momentum and is in a relatively healthy state.

Report composed by René Moreau