Mathematical modelling and analysis for advanced structural design, simulation and optimization

Dietmar Hoemberg, TU Berlin, Germany
Carlo Lovadina, University of Milan, Italy
Elisabetta Rocca, University of Pavia, Italy

The term AM (additive manufacturing) indicates a technology in which components or complete structures are constructed through sequences of deposition and/or hardening of layers of material, for example from melting of powders (Laser melting). Therefore, the hardening and solidification of the material, before the application of the next layer, takes place mainly through thermal actions and forms the bulk part. Among the materials used for AM are plastic, metals, cement, and ceramics, as well as polymers, which have interesting and innovative features, such as a possible bio-compatibility and shape memory effects. In general, however, 3D printing technology opens up the possibility of thinking and creating forms that are impossible to obtain with the usual methods. Moreover, this new technology is a promising step towards ways of optimizing and saving material, reducing costs and environmental impact. The theme of prototyping is, moreover, transversal to many sectors and opens the doors to new research lines and applications with a strong impact in different fields and for this reason is increasingly affecting not only the industrial world, but also the university, as testified by the many academic laboratories and programs introduced in the largest universities internationally. The active participation of applied mathematics is absolutely relevant in several directions. First of all the mathematical modeling of AM processes still remains a fairly unexplored field. In particular, the need to introduce macroscopic models that take into account the microscopic effects of the processes, as well as the anisotropy of micro-macro-scale materials, has become increasingly urgent over time both for an applicative and numerical interest.

The Session aims to obtain meaningful answers and stimulate new questions to relevant issues in this field. In particular the Session is meant to stimulate discussions in-between analysts, numerical analysts, and engineers in order to make relevant progresses in the study of different relevant problems like the introduction of macroscopic models capable of describing the microscopic effects, such as anisotropies, or the problem of topology optimization, in order to identify significant parameters or cavities to predict the optimal shape of a printed object, for example.