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Complexity and anisotropy of plastic flow of commercially pure Ti on multiple scales

It is now generally accepted that self-organization of crystal defects leads to a complexity of plastic flow of solids manifesting itself on multiple scales. Investigations of the last two decades have shown that self-organization of defects is an intrinsic property of plastic deformation although in most cases, it does not manifest on the macroscopic scale of deformation curves. The latter remain smooth most often, and the observation of collective behavior requires high resolution techniques. In particular, power-law distributions testifying to self-similar nature of deformation processes were observed for acoustic emission during deformation of various materials. These observations led to a conclusion on the intermittence inherent in the plastic flow. On the other hand, various methods of measuring the local strain field reveal persistently ondulatory deformation modes. The self-organization may be particularly important in the case of hexagonal materials because of their strong anisotropy and combination of different microscopic mechanisms such as dislocation glide and twinning. In particular, the macroscopic heterogeneity of plastic flow of hexagonal materials leads to a non-monotonic three stage evolution of the work-hardening rate which depends on the crystallographic orientation of the tensile axis. It is thus important to investigate the plasticity of Ti on various scales. The presentation is focused on a multi-scale investigation of plastic deformation of a commercially pure Ti using a combination of several experimental techniques relevant to distinct scales of deformation processes. Namely, the macroscopic tensile curves are compared with the evolution of the acoustic emission (AE) and one-dimensional local strain field, as well as with statistical distributions of bursts in the AE and local strain rates. The studied samples are cut along and normal to the rolling direction in order to take into account the anisotropic texture resulting from rolling of titanium.

Biography

Mikhail A Lebyodkin has completed his PhD from the Moscow Institute of Physics and Technology in 1989. He started his career at the Research Institute of Solid State Physics of the Russian Academy of Sciences. He has received the degree of Doctor of Science in 2002. Since 2006 he is the Research Director in the French National Centre for Scientific Research (CNRS), appointed at the Laboratory of Microstructures and Mechanics of Materials (LEM3), University of Lorraine. He is currently the Head of LEM3. His main research interests concern mechanical behavior of materials, self-organization of crystal defects and relationships between mechanical and physical properties (magnetic, electric) of solids.

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