

Processing of nanostructured materials in the high magnetic field: Introduction to the topic

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This presentation is aimed at showing how magnetic field can be used in metallurgical processes, covering all the aspects of applied research: from fundamental effects of the magnetic field to the development of functional alloys and compounds and to suggestions of industrial implementation of field processing.

After a short introduction to the magnetic forces and torques, various effects of the application of an intense magnetic field on the microstructure of materials will be shown. Examples will be taken from different kinds of materials and processing methods.

This “magneto-science” approach (processing in magnetic field) needs dedicated elaboration tools as well as in-situ characterization devices in superconducting magnets, most of them being developed in-house. Some of those instruments will be described.

Among several effects, a focus will be made on the thermodynamic effect of magnetic field on phase equilibria. This effect, that was formerly said to be negligible, has been recently experimentally demonstrated using intense magnetic field available from superconducting magnets. The measurements of phase transformation temperatures has been realized using in-situ dilatation and thermomagnetic measurements in Fe-C-Mn steels, NdFe eutectic alloy and SmCo₅ compounds.

The necessity of finding breakthrough innovations as well as the environmental concern has already pushed forward (and will continue to do so) the use of new technologies becoming gradually mature at an industrial scale. We think that magnetic field processing will be one of these technologies in the near future. Some economical and technical data related to the technology of superconductors used for intense magnetic field generation will be given, together with examples of ongoing industrial processes using this technology. A schematic design of a production line using superconducting magnets will be proposed.