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Structural Characterization and Structure-property Correlation of Nanostructured Superconducting Coated Conductors and Thermoelectric Materials

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Abstract:

Materials drive innovation of devices and materials prepared by innovative technologies were investigated in this study. A microstructural study of device relevant nanostructured energy materials, such as $DyBa_2Cu_3O_{7-x}$ (DyBCO) high-temperature superconductors and Bi_2Te_3 room-temperature thermoelectric materials, are presented by employing analytical Transmission Electron Microscopy (TEM). Both compounds DyBCO and Bi_2Te_3 have a layered anisotropic structure and a number of modern electron microscopy and microanalysis methods have been applied for their investigation. Structure-property correlations of device relevant materials of both compounds were established for a better understanding and thereby improving the performance of these materials by controlling the micro- and nanostructure.

DyBCO based Coated Conductors (CCs), i.e. long-length high-temperature superconducting tapes were fabricated as thin-films by the Inclined Substrate Deposition (ISD) technology. The tapes yielded a critical current density of 1.7-2.1 MA cm^{-2}, which give rise to a **world record** critical current of **1000 A cm^{-1}** for a 6 µm thick superconducting film at 77 K and zero field. In addition, the growth behavior of superconducting DyBCO thin-films deposited by ISD for CCs was investigated and a growth model is presented for the DyBCO growth.

Nanostructured Bi_2Te_3 bulk materials were produced by two different methods: (i) Ar^+ ion irradiation of bulk materials and (ii) Spark Plasma Sintering (SPS) of nanoscale bulk precursors. For the first time, a controlled formation and removal of the natural nanostructure (nns) in bulk Bi_2Te_3 by Ar^+ ion irradiation is shown.