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The electron microscopy of superconducting materials

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A number of new high-tech technologies requires the utilization of superconducting materials. Low-temperature superconductors, operating at liquid helium temperature, like Nb3Sn and NbTi are used for the manufacture of the magnetic coils in the International Thermonuclear Experimental Reactor ITER or Large Hadron Collider (LAC). The transmission/scanning electron microscopy (S/TEM) methods together with the energy dispersive X-ray microanalysis were employed for the study of the early stages of Nb3Sn formation and radiation induced defects. The crystal structure of nonstoichiometric Nb-Sn compound was revealed.
High-temperature superconducting (HTSC) materials are applied in cables, transformers, and other electrical equipment. The improvement of characteristics of modern superconducting could be achieved by changing technologies or exploiting new materials. The implantation of artificial pinning centers to the Y(Gd)BaCuO superconducting layers could increase the current in the tapes. The compounds with perovskite structure could serve as such pinning centers superconducting layers. TEM and high-resolution Cs corrected STEM, energy dispersive microanalysis, and nano electron diffraction were used to reveal the microstructure of different perovskite based precipitates and their orientation relationship with the superconducting layers. One example is presented in Fig.1 where the column-like BaSnO3 (BSO) precipitates together with GdBaCuO (GBCO) are visible. The GBCO exhibited the orthorhombic crystal structure (SG Pmmm a=0.389 nm, b=0.383 nm, c=1.169 nm [1]) and BSO cubic one (SG Pm-3m) a=0.411 nm [2]). The mismatch between the crystal lattices and different crystal structure lead to the different orientation of BSO precipitates in the GBCO layers. Besides, several types of crystal defects were found in the GBCO layers. These peculiarities will be discussed in the presentation. The microstructure of buffer layers and mutual diffusion processes will be considered.
The fabrication of new superconducting materials based on Fe is proposed as a possible replacement for technical devices with large magnetic fields, but also are interesting from the nature of superconductivity point of view. Few Fe1.1Te(Se,S) single crystals and thin films on different substrates were studied. To determine the crystal structure of these materials the use of three-dimensional reconstruction techniques is require. We used high angle annular dark field (HAADF) STEM to determine the occupancy of Fe atoms. The stress in the Fe1.1Te(Se,S) films could affect the superconducting properties and high resolution TEM was used for the investigations of the interfaces and misfit dislocations.
Fig.1.HAADF STEM image of GBCO superconducting layer with columnar BSO precipitate together with correspondent crystal structures

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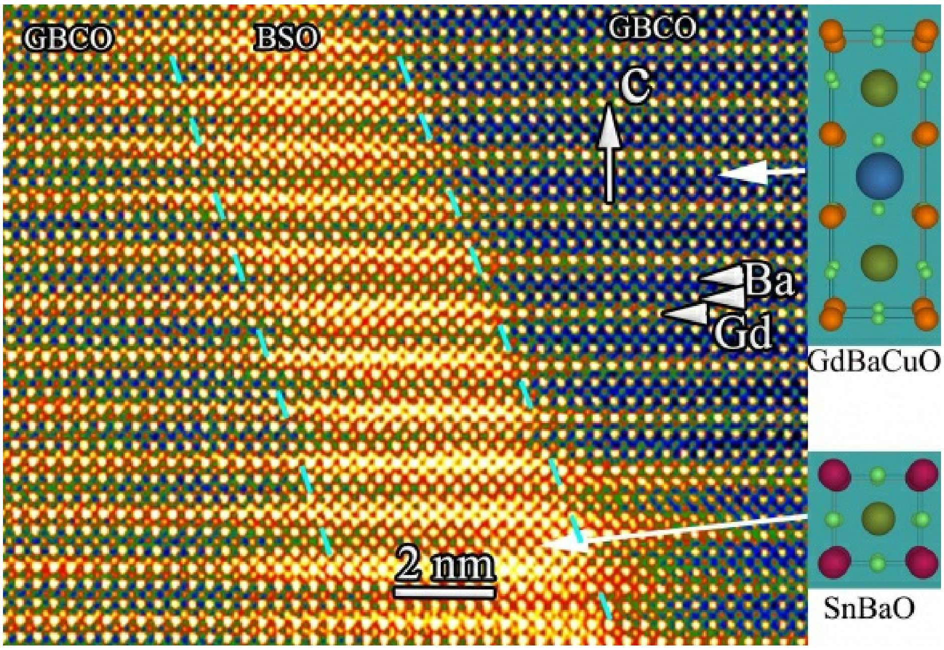

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