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M. R. Koblischka, M. Winter, A. Hu, M. Muralidhar, U. Hartmann and M. Murakami
NANOSCALE FLUX PINNING SITES IN HIGH-TC SUPERCONDUCTORS

Ideal flux pining centres in high-Tc superconductors should be of nanometre size as the coherence length, is so small. Therefore, the optimisation of high-Tc superconductor samples concerning high critical current densities and high flux pinning has to take place in the nanometre range. An important goal of the current research is to find specific preparation strategies to create such ideal flux pining sites already during the sample processing. By means of AFM and STM measurements at ambient conditions, we have investigated the topographies of various samples of YBa2Cu3Ox (YBCO), NdBa2Cu3Ox (NdBCO), SmBa2Cu3Ox (SmBCO), (Sm,Eu,Gd)Ba2Cu3Ox (SEG) and (Nd,Eu,Gd)Ba2Cu3Ox (NEG) high-Tc superconductors. We find that the two systems with the highest critical current densities (NEG, SEG) and hence, the strongest flux pinning, exhibit microstructures on the nanometre scale which are remarkably different from those obtained in the YBCO system. The stripe-like growth structures observed in our topography measurements may be the key for the considerable improvements concerning the critical current densities especially at high magnetic fields and elevated operating temperature (77 K).

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M. R. Koblischka and U. Hartmann
ANALYSIS OF HIGH TC SUPERCONDUCTOR COMPOUNDS ON THE NANOMETRE SCALE

Due to the small coherence lengths of the high-Tc compounds, effective pinning sites are defects or particles of nanometer size according to 3. Integral magnetic measurements of the magnetization as a function of temperature in large applied magnetic fields (up to 7 T) have revealed that practically all high-Tc compounds exhibit spatial inhomogeneities, which can be caused by either oxygen deficiency (YBCO), solid solutions of Nd/Ba (NdBCO and light rare earth 123-type compounds), intergrowths (Bi-based superconductors) or chemical doping by pair-breaking dopants like Zn, Pr, etc. Such local variations of the superconducting properties should be visible in low-temperature scanning tunneling microscopy experiments, and their effects on flux pinning could be studied in a direct way. Various irradiation experiments by neutrons, protons, and heavy-ions have enabled the artificial introduction of effective pinning sites into the high-Tc samples, thus creating many different observations in the integral magnetic data. Furthermore, several sub-structure formations are found in several multi-light rare earth 123-superconductor samples by means of AFM investigations, which may play an important role for the considerably improved critical current densities in these materials. From all these observations, we construct a pinning diagram explaining many features observed in high-Tc samples.

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I. Knittel and U. Hartmann
LORENTZ MAGNETORESISTANCE OF THIN FILMS IN THE PRESENCE OF SURFACE SCATTERING AND DOMAIN STRUCTURES

A modeling of ballistic electronic transport in thin films with diffuse surface scattering in the presence of a magnetic domain structure is performed. The conductance is obtained from the diffusive mean-square displacement of the conductance electrons. Lorentz magnetoresistance (LMR) effects for several domain structures are simulated and compared to corresponding experiments. We conclude that there is no reason to assume an intrinsic domain-wall resistance (DWR) in pure iron and cobalt films in order to explain experimental results. More generally, simulation results indicate that additional LMR related to the domain structure is best understood in terms of three separate effects, which all scale with the LMR of the homogenously magnetized film.

J. Magn. Magn. Mat. ***294****, 16 (2005)*

A. Hu, I. Hirabayashi, M. Winter, M. R. Koblischka, U. Hartmann and H. Zhou
NANOSCOPIC NETTED STRUCTURE OF COMPOSITIONAL MODULATION IN (SM0.33EU0.33GD0.33)BA2CU3O7-Δ SUPERCONDUCTORS

We report a nanoscaled crisscross network in high-quality melt-processed $(Sm_{0.33}Eu_{0.33}Gd_{0.33})Ba_2Cu_3O_{7-\delta}$ superconductors investigated with atomic force microscopy (AFM) and transmission electron microscopy. In the ten-micrometer scale, such a net was unveiled as a consequence of crossing annular stripes originating from ordering compositional modulation. The AFM topographic images further displayed that this compositional stripe result in a surface modulation with a few-nanometer wavelength and roughness. The forming mechanism of this compositional stripe and its role as strong δT_c-type pinning defects were discussed in the context of rare earth/Ba oscillation around the stoichiometric ratio and the spatial fluctuation of local T_c values.

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A. Hu, X.Yao, M. Winter, H. Zhou, N. Sakai, M. R. Koblischka, M. Murakami, U. Hartmann and I. Hirabayashi
NANO-STRIPES IN SMBA2CU3O7-Δ SINGLE CRYSTALS:ORIGIN AND PEAK EFFECT

Nanoscopic surface stripes were observed in high quality SmBa2Cu3O7-d single crystals grown by a top-seeded pulling growth and their roles on the peak effect and enhanced flux pinning were investigated with a SQUID magnetometer. The crystal surface exhibited an ordered modulation with a roughness of 1–2 nm and a wavelength of about 50 nm. The study evidenced that such a periodic array is not dependent on surface processing. The analysis further unveiled that nanoscaled stripes may act as a kind of dTc-style pinning defects which contribute to an enhanced peak effect.

Proc. ISS 2004, Niigata, Japan, 2004; Physica C ***426-431****, 441-445 (2005)*

H. Gao, C. Stockhammer, Th. Heuer, U. Hartmann
ISMAEL - INTELLIGENT SURVEILLANCE AND MANAGEMENT FUNCTIONS FOR AIRFIELD APPLICATIONS BASED ON LOW COST MAGNETIC FIELD DETECTORS
Proc. ITS Conf. Hannover, Germany (2005)

I. Knittel, M. Gothe, and U. Hartmann
QUANTITATIVE ANALYSIS OF THE SPUTTERING PROCESS FOR SMALL MAGNETRON SET-UPS

Sputter deposition of titanium in argon from a small circular magnetron is characterized. The dependence of the deposition rate on pressure, power, and target–substrate distance has been measured. A framework for the application of the analytic approach by Keller and Simmons of ballistic and diffusive transport to simple three-dimensional sputter geometries is developed and applied. The sputter yield and the pressure–distance product are determined from the data set as the only fit parameters of the model. For the entire range of operation of the magnetron, the sputter process can be described in terms of the relatively simple approach.

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H. Gao, Th. Heuer, U. Hartmann, M. Weinmann, C. Stockhammer, N. Grammalidis, I. Gragopoulos, and K. Dimitropoulos
ISMAEL - INTELLIGENT SURVEILLANCE AND MANAGEMENT FUNCTIONS FOR AIRFIELD APPLICATIONS BASED ON LOW COST MAGNETIC FIELD DETECTORS
Proc. JISSA Conf., Paris, France (2005)

U. Hartmann
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