TT 2: SC: Applications and Measuring Devices

Time: Monday 10:15–12:30 Location: H19

TT 2.1 Mon 10:15 H19

Josephson-Cantilever with integrated THz antenna — •Christian Brendel, Heiko Neeland, Tobias Vosskoetter, Jan M. Scholtyssek, and Meinhard Schilling — Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik, Technische Universität Braunschweig, Hans-Sommer-Str. 66, D-38106 Braunschweig, Germany

We imaged the three dimensional microwave power distributions at the open end of multimode circular waveguides and in the free space in the THz range. The measurement setup consists of a grating-tuned CO_2 laser (emission 9 - 11 μm) to pump a FIR laser with an output frequency range from 584 GHz up to 4.2 THz. As scanning sensor we employ a Josephson junction from the high-temperature superconductor $YBa_2Cu_3O_7$ on a vibrating cantilever prepared from a $LaAlO_3$-bicrystal. The setup is mounted inside a vacuum chamber on x-, y- and z-tables with submicrometer resolution and is cooled to a temperature of about 50 K by a cryocooler. We realized a quasi-optic THz-lens system and determined the beam parameters at the Josephson-cantilever position. The small change of the differential resistance in the Shapiro step is proportional to the microwave power. To improve the signal to noise ratio in the measured curent voltage curve we developed new Josephson cantilever designs with different THz antenna strutures.

We wish to acknowledge the financial support of C. Brendel by the Braunschweig International Graduate School of Metrology.

TT 2.2 Mon 10:30 H19

Metallic magnetic calorimeters for high-resolution x-ray spectroscopy — •Jan-Patrick Porst, Sebastian Kempf, Andrea Kirsch, Andreas Pabinger, Christian Pies, Philipp Ranitzsch, Sönke Schäfer, Falk von Seggern, Loredana Gastaldo, Andreas Fleischmann, and Christian Enss — Kirchhoff-Institut für Physik, Universität Heidelberg, INF 227, 69120 Heidelberg

Metallic magnetic calorimeters (MMC) are calorimetric particle detectors, typically operated at temperatures below 100 mK, that make use of a paramagnetic temperature sensor to transform the temperature rise upon the absorption of a particle in the detector into a measurable change of magnetic flux in a dc-SQUID. During the last years we have started to develop MMCs for a wide variety of applications, ranging from beta- and gamma-spectrometry over the spatially resolved detection of accelerated molecule fragments to arrays of high resolution x-ray detectors. For x-ray energies up to 6 keV an energy resolution of 2.7 eV (FWHM) has been demonstrated and we expect that this can be pushed below 1 eV with the next generation of devices. We summarize the physics of MMCs and the presently used readout schemes as well as the typically observed noise contributions and their impact on the energy resolution. We discuss general design considerations, the micro-fabrication and the performance of micro-fabricated devices. In this field large progress has been achieved in the last years and the thermodynamic properties of most materials approach bulk values allowing for optimal and predictable performance.

TT 2.3 Mon 10:45 H19

Moving a vortex by the tip of a magnetic force microscope — •Ernst Helmut Brandt — Max-Planck-Instiut für Metallforschung

In a recent paper [1] a magnetic force microscope (MFM) was employed to image and manipulate individual vortices in a thick single crystal of $YBa_2Cu_3O_7$. When the magnetic tip performed a zig-zag motion, wiggling fast along x and moving slowly along y, a large enhancement of the excursion of the vortex end at the upper surface (in the crystalline a-b plane) was observed along y, the vortex path covered an elliptical area with axes ratio $\max(y)/\max(x) \gg 1$. As a first step towards a more detailed theory, we consider the vortex as an elastic string which is uniformly pinned by point defects and is driven by the magnetic force exerted on the vortex near the surface by the tip of the MFM. The tip is approximated by a magnetic monopole and the anisotropy of $YBa_2Cu_3O_7$ in the a-b plane is accounted for. When the tip moves with wiggles, the vortex is curved and twisted, its motion penetrating to a maximum depth z_0 below which the vortex remains rigidly pinned in its straight initial position. Our theory [2] reproduces the path of the vortex end observed in the experiments [1].

[1] O. M. Auslaender et al., Nature Physics **5**, 35 (2009).

[2] E. H. Brandt, G. P. Mikitik and E. Zeldov, Phys. Rev. B **80**, 054513, 1-10 (2009).

TT 2.4 Mon 11:00 H19

Barriers for vortex avalanche propagation in MgB_2 thin films — •Sebastian Treiber[1] and Joachim Albrecht[2] — [1]Max-Planck-Institut für Metallforschung, Stuttgart, Germany — [2]Hochschule Aalen, German

At temperatures below 10K the critical state in MgB_2 thin films gets unstable. This leads to chaotic motion of magnetic vortices and dendritic flux density patterns. Since the critical current is zero inside the dendrites this effect leads to a strong suppression of possible transport currents.

We prepared MgB_2 films containing areas of different current densities and thermal conductivities, respectively. Magneto-optical investigations revealed that the propagation of vortex avalanches can be manipulated by this local variations. It is found that boundaries to areas of higher current density or enhanced thermal conductivity can act like a barrier for the dendrites. The investigations also show that the critical current density around the dendrites is not constant which can not be described by classical critical state models.

TT 2.5 Mon 11:15 H19

Energy relaxation processes in YBCO thin films studied by frequency and time-domain techniques — •Petra Probst[1], Dagmar Rall[1,2], Matthias Hofherr[1], Stefan Wünsch[1], Konstantin Ilin[1], and Michael Siegel[1] — [1]Institut für Mikro- and Nanoelektronische Systeme, Karlsruher Institute of Technology, Hertzstrasse 16, 76187 Karlsruhe, Germany — [2]Lichttechnisches Institut, Karlsruher Institute of Technology, Engesserstrasse 13, 76131 Karlsruhe, Germany

The development of ultra-fast detectors with time resolutions in the picosecond range requires the analysis and understanding of the dynamics in the energy relaxation processes in thin films. A systematic study of the energy relaxation processes in YBCO thin films on sapphire substrate has been performed. Pulsed-laser deposited YBCO samples between 20 and 60 nm film thickness were fabricated and characterized by means of frequency and time domain techniques by excitation of the samples with optical radiation. The characteristic energy relaxation time was extracted from the thin film sample response according to the two-temperature model. The extracted time constants of the two techniques showed good agreement. We have observed an increase of the energy relaxation time from 500 ps to 4 ns with increase of the film thickness from 20 to 60 nm, respectively. The obtained dependence of the characteristic time on film thickness we attribute to the escape of non-equilibrium phonons from the YBCO films into substrate. Details of the experimental methods and results on the energy relaxation in thin YBCO films and the applied theoretical model will be discussed.

15 min. break

TT 2.6 Mon 11:45 H19

AC loss data for YBCO double-pancake coils — Christian Stiehler[1], •Vadim Grinenko[1], Konstantin Nenkov[1], Michal Vojenciak[2], Günter Fuchs[1], Bernhard Holzapfel[1], and Ludwig Schultz[1] — [1]Leibniz Institute for Solid State and Materials Research Dresden, Helmholtzstraße 20, 01067 Dresden, Germany — [2]Institute of Electrical Engineering, Slovak Academy of Sciences, Dubravsk'a cesta 9, 841 04 Bratislava, Slovak Republic

Since the second generation of superconducting tapes, YBCO coated conductors, are commercially available, large scale AC applications seem to be very promising provided that AC loss of the 2G tapes can be reduced. In this work, critical current measurements as well as AC loss experiments of YBCO double-pancake coils and 2G tapes were performed. An analysis of the magnetic field distribution at the coil's exterior, especially in critical points, shows no self-field limitation of the critical current density. Magnetisation loss data were obtained for YBCO double-pancake coils by applying magnetic AC fields at 77 K. It is demonstrated that the AC loss can be reduced by means of magnetic shielding. Furthermore, AC transport losses have been measured at temperatures between 65 and 77 K for frequencies between 36 and 288 Hz. The AC loss data were found to be dominated by hysteresis losses. The obtained results are compared with AC loss data reported for YBCO pancake coils.

TT 2.7 Mon 12:00 H19

Development of a micro-Hall magnetometer for the study of light-induced effects in magnetic molecules — •Robert Lusche, Jan Dreiser, and Oliver Waldmann — Physikalisches Institut, Universität Freiburg, D-79104 Freiburg, Germany

Controlling magnetic properties in magnetic molecules with light is an intriguing effect and has recently attracted renewed interest [1]. In order to measure the magnetization in the presence of light we rely on micro-Hall-senors in our setup. Micro-Hall probes have been proven to be a simple and robust tool for magnetic measurements over a large range of experimental conditions. Here we present the design of our home-built micro-Hall magnetometer including an irradiation unit. It can be operated at temperatures down to 1.4 K and with magnetic fields of up to 5.5 T, and provides a resolution better than 10^{-7} emu. We demonstrate and characterize the performance by measurements on known spin-crossover complexes, and present first measurements on novel photomagnetic complexes.

[1] A. Bleuzen *et al.*, Inorg. Chem. **48**, 3453 (2009).

TT 2.8 Mon 12:15 H19

Coherent broadband continuous-wave THz spectrometry: A powerful tool for low-energy solid-state spectroscopy at low temperature and high magnetic field — •Komalavalli Thirunavukkuarasu[1], Holger Schmitz[1], Axel Roggenbuck[2], Andreas Janssen[1], Anselm Deninger[2], Iván Cámara Mayorga[3], Joachim Hemberger[1], Rolf Güsten[3], and Markus Grüninger[1] — [1]II. Physikalisches Institut, Universität zu Köln, D-50937 Köln, Germany — [2]TOPTICA Photonics AG, Lochhamer Schlag 19, D-82166 Gräfelfing, Germany — [3]Max-Planck Institute for Radio Astronomy, Auf dem Hügel 69, D-53121 Bonn, Germany

We present the development of a continuous-wave THz spectrometer and its application at low temperatures and high magnetic fields. The spectrometer employs photomixing of two NIR-DFB diode lasers for generation and phase sensitive detection of THz radiation of frequency from 60 GHz to 1.8 THz. A phase modulation technique and photocurrent correction are used to accurately determine amplitude and phase at a given frequency, and to correct for instabilities, respectively. The complex optical functions can be evaluated from the full THz phase information, and a very high spectral resolution in the MHz range can be achieved. Furthermore, this compact spectrometer can be integrated within a magnetic cryostat eliminating the need for optical windows. In this way, the investigations at high magnetic fields up to 16 T and low temperatures up to 2 K can be achieved without loss of intensity. Thus, a new door is opened for exploring low-energy electronic excitations of novel materials, lying in the sub-phonon energy regime.