TT 51: Focus Session: Electric Power Applications of Superconductivity

Cuprate high-temperature superconductor (HTS) and MgB_2 based conductor material has meanwhile reached a stage of technical maturity and commercial availability that enables the engineering of many novel high-current applications which are of considerable interest for electric power systems. Topical projects investigate their insertion into established electrical grids in industry and advanced science environments. This Focus Session wants to show which technical achievements have actually been made since the initial euphoria after HTS discovery nearly three decades ago.

Organizers: Bernd Holzapfel (KIT), Roland Hott (KIT), and Kurt Scharnberg (Uni Hamburg)

Time: Wednesday 9:30–12:15 Location: H 0104

Invited Talk TT 51.1 Wed 9:30 H 0104

High Power Equipment based on High-Temperature Superconductors: the Added Value from an Industrial Point of View — •Tabea Arndt, Michael Frank, Jörn Grundmann, Anne Kuhnert, Peter Kummeth, Hans-Peter Krämer, Wolfgang Nick, Marijn Oomen, and Christian Schacherer — Siemens AG, CT RTC PET SUC-DE, Erlangen, Germany

The development and production of High-Temperature Superconductors (HTS) especially in the form of long length wires and tapes has made tremendous progress in the last two decades. A first implication is the steadily increasing number of applications in power technology based on these superconductors. A second implication is that some of the challenges related to the specific devices can not be addressed by academia alone anymore. Nevertheless the industrial players will definitely need support from science and young academics.

This contribution will report on the main properties relevant for application creating 'unique selling points' and the progress in HTS wires and the technology readiness level of selected devices and applications in power technology (e.g., motors, generators, magnets and fault current limiters).

There are some success stories to be covered. We will comment on remaining challenges in material and in bridging the gap of a 'technology push' to a 'market pull'. Finally an outlook is given on near term applications in power technology.

Topical Talk TT 51.2 Wed 10:00 H 0104

Conductors and Cables from REBCO High Temperature Superconductors for Applications — •Wilfried Goldacker — Karlsruher Institut für Technologie - ITEP, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Deutschland

The availability of commercial REBCO high temperature superconductor (HTS) tapes enables a couple of applications in magnets, current limiters, power lines, transformer and rotating machinery. The HTS material has to be conditioned or assembled to cables for the different applications to achieve the required currents and technical features. The conductor performance, however, is still far from perfection, in particular the homogeneity of the current carrying capacity. Features requested for the specific application are very high operation currents, low AC losses, thermal and mechanical stabilization and filament structures. We review typical REBCO tape features and show the impact on the designs and efforts to develop high current cables from such tapes, including a review of the running investigations in different laboratories. Two of the most promising and advanced cables presented in detail, the Roebel cable and the CORC cable (Conductor on round core), are concepts with transposition of the strands and reduced AC losses. The status of the development, the cable features under different aspects, the achieved transport currents and the future potential are discussed. Finally examples for applications, as HTS fusion or accelerator magnets, are addressed with the related conductor development, followed by conclusions on the expected future potential of the material for such purpose.

Topical Talk TT 51.3 Wed 10:30 H 0104

Power Transmission via Superconducting Lines — •Amalia Ballarino — CERN, 1211 Geneva 23, Switzerland

Superconductivity is an enabling technology for high energy physics. Accelerators made with high field superconducting magnets have allowed ever deeper exploration of the structure of matter over the years culminating in the recent discovery of the Higgs boson at the Large Hadron Collider (LHC) at CERN. This particle accelerator contains 1200 tons of high-performance Nb47Ti superconductor operated at superfluid helium temperature, and it represents today the largest application of superconductivity for high energy physics. An accelerator requires magnets for steering and focusing of the particle beams, but also requires sophisticated equipment for feeding the current from the room temperature environment of the power converters to the cryogenic environment of the associated electrical circuits. To cover this function, novel electrical transfer lines are being developed at CERN in the framework of an upgrade of the LHC to increase the brightness of the interactions. These lines are made using magnesium diboride (MgB_2) and high temperature superconductors, are several hundred meters long, are operated in helium gas at temperatures of up to 25 K, and have a total current-carrying capability of greater than 150 kA. The development done at CERN in the framework of superconducting power transmission for accelerators is presented. The application of this technology to other power transmission systems is also discussed, as well as other electric power applications of superconductivity.

15 min. break.

Invited Talk TT 51.4 Wed 11:15 H 0104

High field transport properties of MBE processed Fe-based superconducting thin films — •Kazumasa Iida — Nagoya University, Japan — IFW Dresden, Germany

It has been reported that Fe-based superconductors show high upper critical fields with low anisotropies at low temperatures [1]. Hence these materials may offer a unique possibility for high field magnet applications. However, only a few reports on high-field transport properties of Co-doped Ba-122 and Fe(Se,Te) have been published and the only one for SmFeAs(O,F) thin films to date [2-4]. In order to use this material class for applications, the knowledge of in-field and its orientation dependence of transport properties in a wide range of external fields need to be clarified. In this talk, I will report on high-field (up to dc 45 T) transport properties of P-doped Ba-122, SmFeAs(O,F) and NdFeAs(O,F) thin films prepared by MBE. Although P-doped Ba-122 has the lowest T_c, self-field J_c of over 6 MA/cm^2 at 4.2 K is recorded, which is the highest value ever reported in Fe-based superconductors. Additionally, in-field performance of P-doped Ba-122 shows comparable to those of NdFeAs(O,F) and SmFeAs(O,F) for $H||c$. On the other hand, both NdFeAs(O,F) and SmFeAs(O,F) exhibited higher J_c for $H||ab$ due to the intrinsic pinning [4]. These results indicate that P-doped Ba-122 is the most promising candidates for high-field magnet applications.

[1] M. Putti et al., Supercond. Sci. Technol. **23**, 034003 (2010)
[2] C. Tarantini et al., Phys. Rev. B **86**, 214504 (2012)
[3] Q. Li, W. Si, and I. K. Dimitrov, Rep. Prog. Phys. **74**, 124510 (2011)
[4] K. Iida et al., Sci. Rep. **3**, 2139 (2013)

Topical Talk TT 51.5 Wed 11:45 H 0104

Advanced Superconducting Power Cable for MV Urban Power Supply — •Frank Schmidt[1], Frank Merschel[2], and Mathias Noe[3] — [1]Nexans Deutschland GmbH, Hannover — [2]RWE Deutschland AG, Essen — [3]Karlsruhe Institute of Technology, Karlsruhe

In recent years the technology of superconducting power cable systems has progressed such that the technical hurdles preparing for commercial applications have been mastered. Several field tests of large scale prototypes for the applications of superconducting cables as well as superconducting fault current limiters have been successfully accomplished and the technology of such systems is ready for commercialization. The presentation will give a detailed overview of the German AmpaCity project. An overview will be given on the development, manufacturing and installion of the 10 kV, 40 MVA HTS system con-

sisting of a fault current limiter and of a 1 km cable in the city of Essen. Since it is the first time that a one kilometer HTS cable system is installed together with an HTS fault current limiter in a real grid application between two substations within a city center area, AmpaCity serves as a lighthouse project. In addition it is worldwide the longest installed HTS cable system so far. It is expected that relatively large technical advances will be made in the future of the comparatively new HTS technology, which in turn will bring associated cost reductions. For this reason, the AmpaCity pilot project in the downtown area of Essen in Germany will be an important step on the way to achieving more widespread application of HTS technology.