Production of High Temperature Superconducting Tapes enhanced by Computational Thermochemistry

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ABSTRACT

About 100 years after the discovery of superconductivity by Heike Kamerligh Onnes the promises of superconductivity for revolutionizing energy applications start to become true. A new generation of superconducting materials and production processes enables new applications such as cables, motors, generators, magnets and fault current limiters.

Two outstanding properties of high temperature superconductors when cooled under their critical temperature break paradigms in electro technology:

1. No ohmic restistance
2. Highest energy density

High temperature superconducting materials were discovered in 1986 by Bednorz and Müller. For all energy applications only HTS are applicable due to their superior operating temperature compared to low temperature superconductors. In order to be usable in electric devices the ceramic oxide-based HTS materials have to be processed to windable wires or tapes. The second generation (2G) of HTS tapes are therefore based on thin film technology. The layer architecture of these so called Coated Conductors consist on a metal substrate, buffer layers as diffusion barriers and the HTS layer based on Yttrium-Barium-Copper-Oxide. The most promising but also most demanding deposition technique for these layers is the chemical solution deposition method (CSD). One major drawback of this technology is the necessity for long term high temperature annealing resulting in strong interaction of the involved phases.

In order to minimize experimental efforts and to understand phase formation thermo chemical calculations in cooperation with GTT Technologies were performed for all single buffer and superconducting layers in a second step their interaction at interfaces. Encouraging results of these calculations led to a deeper understanding e,.g. of influences of stochiometry variations on the phase formation, which was not satisfactory explained before.

This work was funded by the German Ministry of Economy (BMWi) under project number 0327433.