Contribution ID: **23** Type: **Plakat // Poster**

Search for improved synthesis and enhanced properties of the Mo-substituted YBa2Cu3O7-d superconductors

Monday, 8 September 2025 18:00 (20 minutes)

High-temperature superconductors YBa2Cu3O7-d of the 123-type are important for applications at liquid nitrogen temperatures (77 K) where they show zero resistance to the direct current. They exhibit high values of the critical current densities, jc, and irreversibility fields, Hirr, and are unique for use in magnetic fields above several Tesla. By studying the polycrystalline and single-crystals of Mo-substituted YBa2Cu3O7-d superconductors when the Mo is exclusively placed in the CuO chains region of the structure we have shown that the density of critical currents can be significantly increased by the extended defects made of the coupled MoO6 octahedra that produce local disturbance with the size similar to the coherence length [1,2]. Our results demonstrated promising results for enhanced critical currents density in crystals annealed under high pressure oxygen by 2-3 times at temperatures 4-40 K in B = 1-14 T, and by ~10 times at 60-80 K and B = 1-4 T [3]. However, the synthesis conditions, which are required to keep the Mo away from the CuO2 planes and to tune the optimum oxygen content, were too complex for use of these materials for applications, for example in thermonuclear fusion. We will summarize our recent efforts intended to simplify the synthesis, increase the superconducting Tc as well as to achieve higher values of critical currents and irreversibility fields. This work involved additional substitutions with the small size cations for Cu and the use of larger Rare Earth's for Y.

[1] K. Rogacki, B. Dabrowski, O. Chmaissem, and J. D. Jorgensen, PRB 63 (2000) 054501.
[2] K. Rogacki, B. Dabrowski, and O. Chmaissem, PRB 73 (2006) 224518.
[3] K. Rogacki, A. Los, and B. Dabrowski, Low Temp. Phys. 49 (2023) 1.

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Session Classification: Sesja plakatowa

Track Classification: Fizyka materii skondensowanej // Condensed matter physics