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# In-Situ Measurement of the Resistivity during Annealing of Neutron Irradiated High-Temperature Superconductors

## Diplomarbeit


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# Abstract

Nuclear fusion has been researched for decades as a potential energy source of the future. Generating the necessary high magnetic fields for fusion conditions, high-temperature superconductors offer advantages compared to low-temperature superconductors by achieving higher critical current densities under strong magnetic fields, possibly leading to smaller reactor dimensions. One of the challenges of employing HTS is the degradation of superconductors when they are exposed to neutron radiation. This master thesis extends previous research on the recoverability of the superconducting properties of HTS, specifically REBCO (GdBCO and YBCO) conductors, after neutron irradiation by thermal treatments. It has been shown that the critical temperature decreases linearly with neutron fluence and increases linearly with annealing temperature, while the critical current density recovers non-monotonically. In order to improve our understanding of the underlying physics, the evolution of the resistivity under high temperature thermal annealing in a pure oxygen environment will be measured. For this purpose, a new sample holder will be designed and manufactured. It is expected that the collected data of the change in resistivity at different temperatures will provide information on which physical processes lead to the recovery of the critical temperature and the closely related critical current density. The critical temperature and the critical current density will be measured before and after neutron irradiation in the 17 T cryostat. The neutron irradiation will be performed in the central irradiation position of the TRIGA Mark II reactor at 250 kW. Scanning Hall Probe Microscopy will be used to determine the homogeneity of the magnetic profiles. Additionally, the fast and thermal neutron flux will be determined both in the central irradiation position and the central irradiation tube outside the graphite reflector of the TRIGA Mark II reactor at 250 kW by material activation measurements. This is done to accurately determine the defect density in the irradiated superconductors, which is proportional to the neutron flux. This is especially relevant for GdBCO conductors, as the degradation of the critical temperature is 14 to 15 times stronger compared to thermally shielded samples due to neutron-gamma capture reactions of Gadolinium. As the neutron field of the TRIGA Mark II reactor differs from a fusion reactor, an accurate description of the neutron flux is essential to evaluate the significance of our observations and assess its limitations.