The influence of crystal structure defects on magnetic properties of superconductors

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Materials exhibiting superconductivity are an object of interest in many branches of science, industry, medicine and energetics. The results of our group showed that type-I superconducting materials may convert into type-II by deformation of a crystal lattice. Additionally, in the case of type-II superconductors, after plastic deformation, their superconducting properties may be enhanced. The study was performed on tantalum [1], rhenium and indium, which are type-I superconductors and vanadium, which is type-II. The samples were prepared by arc-melting technique under argon atmosphere and cold-rolled at room temperature, After the first series of measurement, samples were annealed and cooled down slowly to room temperature.

To define types and concentration of structural defects it had been used Positron Annihilation Lifetime Spectroscopy. Those measurements revealed that cold-rolled samples contained a high concentration of structural defects like dislocations and vacancies, while the annealed ones were almost free of any defects. The magnetic measurements were made with a Superconducting Quantum Interference Device. Our results give clear evidence that the behavior of the superconducting phase depends on the concentration of structural defects (see Fig.1).

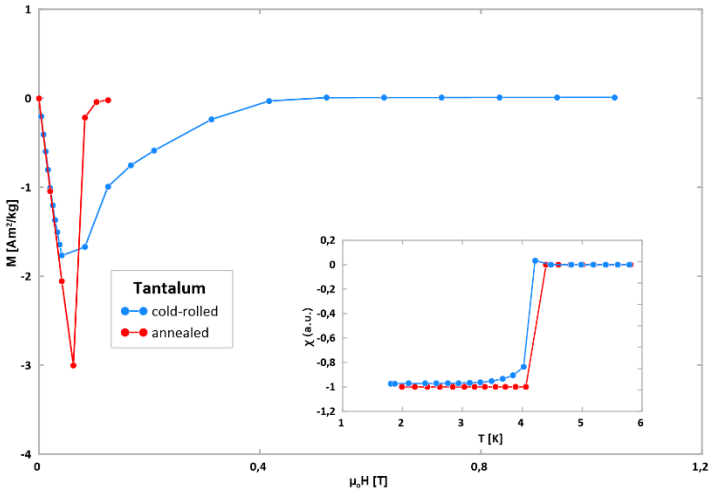

Fig.1. Magnetization at 2 K versus applied field measured for the cold-rolled and the annealed tantalum samples with the temperature dependence of dc-susceptibility at 0.001 T.

[1] R. Idczak, W. Nowak, M. Babij, and V.H. Tran. Type-II superconductivity in cold-rolled tantalum. Physics Letters A, 384(28):126750, 2020.