The heat treatment of MgB_2 superconductors with different metal sheaths

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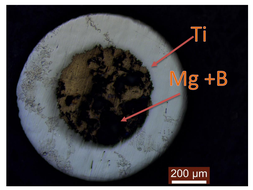
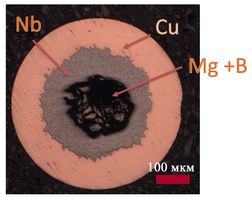
Experimental details





The microstructure of the conductors after annealing were investigated using scanning electron microscope Carl Zeiss Nvision 40 with the prefix Oxford X-Max. The critical temperature of the samples was measured by a resistive method.

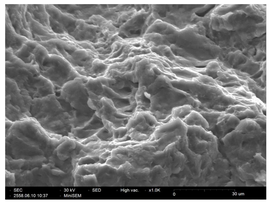
The powder –in- tube method was used to fabricate the Ti and Cu/Nb –sheathed MgB_2 wires. We crimped to seal one end of the titanium and Cu/Nb tube, and then filled the tube with the desired precursor powder. The remaining end of the tube was crimped afterwards. Commercially available Mg powder (nominally 99,9% pure, 60-160 µm) and B powder (nominally 99,99% pure, amorphous phase, 2-3µm) were stoichiometrically mixed.

The entire filling procedure was carried out in an argon atmosphere. We drawed the powder-filling tube up to 1-2 mm in dia. Then the superconductors were heated at 650°C for 0,25h; 650°C for 0,5h; 650°C for 1h and 700°C for 2h. A high purity argon gas flow was maintained throughout the heat treatment process to avoid the oxidation of titanium sheath

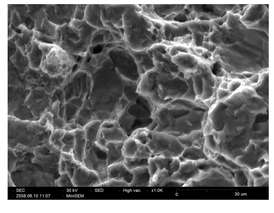
Microstructure of strands after heat treatment

MgB_2 superconductors with Ti sheath, 1 mm in dia

650°C, 0,25h

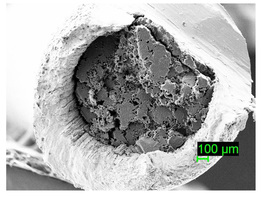


650°C, 0,5h



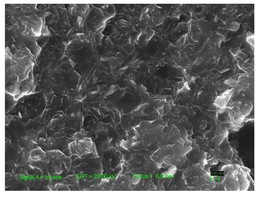
MgB_2 superconductors with Ti sheath, 2 mm in dia

700°C, 1h

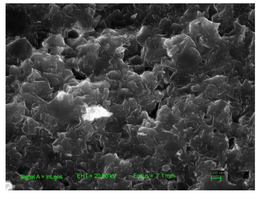


MgB_2 superconductors with Cu/Nb sheath, 1mm in dia

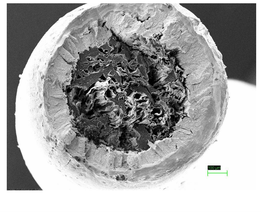
650°C, 0,25h



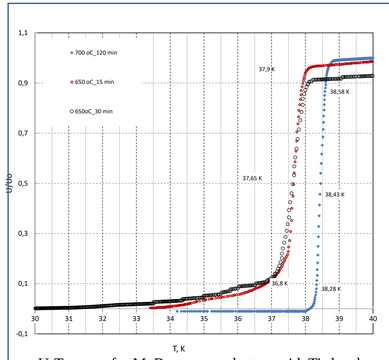
650°C, 0,5h



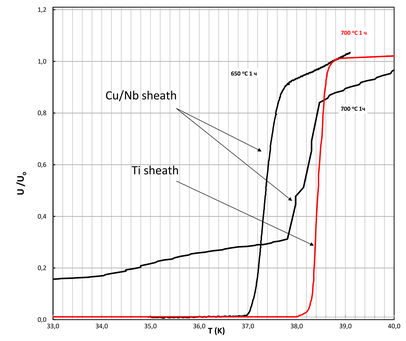
650°C, 1h

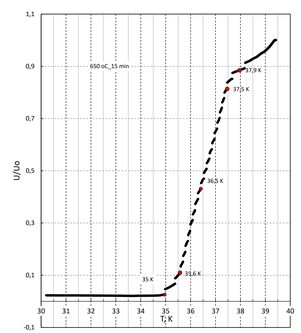


The results of critical temperature measurements



U-T curves for MgB_2 superconductors with Ti sheath





U-T curves for MgB_2 superconductors with Cu/Nb sheath

The results of the critical temperature measurements of the superconductors with Cu/Nb and Ti sheath, attorney for different heat treatment indicate the formation of superconducting compound after all annealing. For samples with a with Cu/Nb sheath it was shown that the critical temperature increases with the incensement of temperature and duration of annealing up to 700°C and 1h.

Conclusions

- It was shown that at low exposure at a temperature close to the melting point of magnesium, the process of formation of the superconducting compound conductor with Cu/Nb sheath is more intensively in compare with conductor with Cu/Ti sheath . This is due to much higher thermal conductivity of copper compared with the conductivity of titanium. Thermal conductivity of niobium can be neglected due to small thickness of the layer of this material.
- With increasing time of exposure at for samples with a with Cu/Nb sheath the critical temperature increases .
- Particles of the superconducting compound are needle-like, layered form. This is especially pronounced for superconductors with Ti sheath. This indicates the formation of the superconducting compound according to the mechanism Chernova.
- A small difference in the temperatures of the beginning and end of the superconducting transition in superconductors with a sheath of titanium compared to the samples with Cu/Nb sheath testifies to the composition of the superconducting phase close to stoichiometric.