crystal growth and magnetostriction of high-temperature superconductors
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Concluding remarks

In this section, an overview will be given of the different aspects encountered during the magnetostriction study performed on single-crystalline samples of three different superconducting compounds.

\( V_3\text{Si} \):

The magnetostriction measurements on \( V_3\text{Si} \) are largely influenced by the martensitic transformation from a cubic structure to a tetragonal structure. The magnetostriction curves show a large negative contribution, being independent of temperature and orientation, and a hysteretic part. The thermal expansion measurements performed in three directions proved that at \( T_c \) the sample is only partly transformed to the tetragonal structure. By applying a magnetic field the remaining part of the sample transforms. It is proposed that in the vortex state the part of the sample being in the normal state will transform to the tetragonal structure. The shape of the magnetostriction curve measured at 4.3 K could be reproduced via the measured magnetization and the model based upon flux-pinning described by the Bean model. However, the size of the effect showed a discrepancy coming from an uncertainty in the value of the elastic constant and the simplifications in the model.

\( \text{La}_{1.85}\text{Sr}_{0.15}\text{CuO}_{4.5} \):

Measurements of the magnetostriction parallel to the magnetic field showed a much larger magnetostriction than expected from the magnetization measurements and the model based upon flux-pinning described by the Bean model. The sample is deforming, making the two dimensional model not valid for length changes in a cubic sample parallel to the direction of the magnetic field. Still the shape of the calculated curves, especially at temperatures closer to \( T_c \), resembles the measured curves very well.

\( \text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_{8+\delta} \):

The magnetostriction measurements for field parallel to the ab-planes and relative length change parallel to the c-axis show a large parabolic contribution. This contribution depends
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strongly upon the exact angle between the field and the ab-planes. The absence of hysteresis in this direction could be understood from the absence of hysteresis in the magnetization. The measurements for field and relative length change parallel to the c-axis showed a large hysteresis which could only partly be understood via the hysteresis in the magnetization. The Bi$_2$Sr$_2$CaCu$_2$O$_{8+\delta}$ crystal has such a shape that the model based upon flux-pinning described by the Bean model is not valid for measurements with field and length change parallel to each other.

Magnetostriction of superconductors proved to be a topic with a richness in physical and experimental phenomena. Although many problems were encountered during the measurements most of the phenomena could at least qualitatively be understood. Forces implied on the materials arising from pinned flux lines are the predominant factor for the magnetostriction of high-temperature superconductors. The effect of the relative length changes in bulk samples can be very large (up to 0.5 %) for the configuration with field and length change perpendicular to each other.