

Large enhancement of T_c of the van der Waals superconductor 4Hb-TaS₂ on in-plane uniaxial strain

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Micro-Hall probe magnetometry enables the accurate detection of the vector magnetic field with subgauss sensitivity and micrometer spatial resolution. In superconductors, this technique minimizes disadvantages caused by surface barriers and sample geometry. This allows a precise determination of the field of first flux penetration, from which the temperature dependence of the lower critical field $H_{c1}(T)$ can be estimated [1,2]. $H_{c1}(T)$ is related to the superfluid density, and thus valuable information about the symmetry of the underlying order parameter can be achieved.

Application of the uniaxial strain can narrow down the possible scenarios for the symmetry of the order parameter by lifting the specific crystal symmetries. To this end, we built a differential thermal contraction strain rig capable of applying uniaxial compression of $\sim 0.6\%$ to the sample. The original design [3,4] was adapted to allow mounting of a micro-Hall sensor. The sensor was placed on a specially designed arm, positioning its active area of $40 \times 40 \mu\text{m}^2$ close to the center of the crystal surface. The thin sample was glued to the sample platform made of beryllium copper.

With this strain rig, we performed preliminary measurements of local magnetization of a putative chiral superconductor 4Hb-TaS₂ ($T_c \simeq 3.0$ K) with hexagonal structure. An uniaxial strain was applied along the crystallographic direction [110]. For a sample with thickness $d \approx 20 \mu\text{m}$, we observed the formation of Cooper pairs at T_c^{onset} of around 3.25 K. More remarkably, for the sample with thickness $d \approx 4 \mu\text{m}$ the influence of strain was very strong, resulting in $T_c^{onset} \approx 7.5$ K, which is the highest value ever recorded for this van der Waals heterostructure. The obtained results open a new route for further research on 4Hb-TaS₂ and show great experimental potential of the local magnetization measurements under uniaxial strain.

References:

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