Single Crystal Growth and Physical Properties of Kagome Materials

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Background

The Kagome lattice is a special lattice composed of corner-sharing triangles, with a honeycombed six-membered ring. The Kagome lattice has flat-band, linear dispersive Dirac bands and van Hove singularities. The linear dispersive Dirac band can excite massless quasiparticles, resulting in physical effects such as half-integer quantum Hall effect and Klein tunneling. Due to the annihilation interference of the Bloch wave function, the electrons are localized in six-membered ring, resulting in the formation of flat bands. At this time, the strong correlated electron effect dominates flat band, which may bring novelty physical properties such as ferromagnetism, high-temperature superconductivity, fractional quantum Hall effect, Wigner crystals, Bose-Einstein condensation[1-2]. In addition, the van Hove singularity may cause the appearance of CDW (charge density wave)[3]. Thus, Kagome materials are widely researched.

We have successfully synthesized Kagome superconductivity materials: AV_3Sb_5 (A=K, Rb, Cs), ATi_3Bi_5(A=K, Rb, Cs); Kagome magnetic materials (166 phase): XMn_6Sn_6(X=Tb, Gd, Zr) and other topological Kagome materials: Nb_3Cl_8, Pt_2TlTe_3, Pt_3Tl_2 and so on.

Method

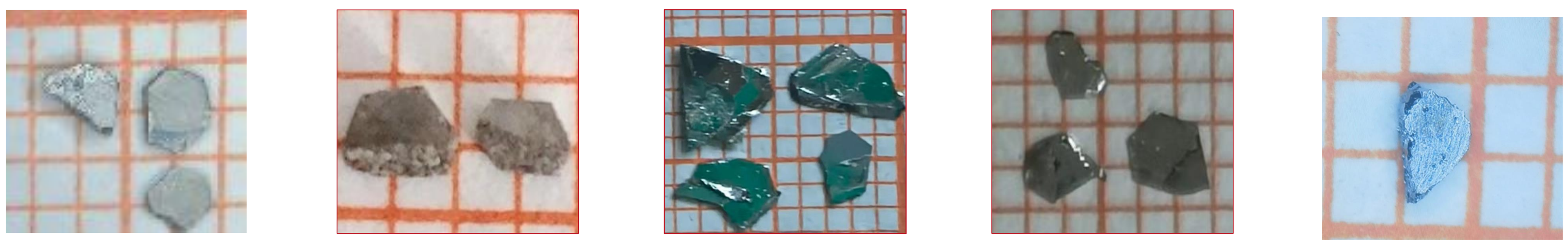
We have grown high-quality Kagome single crystal materials by using some preparation techniques such as melting method, flux method, chemical vapor transport method and Bridgman method. The physical properties of the material were manipulated by substitution of element, intercalation and physical high-pressure.

Kagome superconductivity

Nb、Ta、Mo、Sn and Cr-doped CsV_3Sb_5 — $CsBi_2$

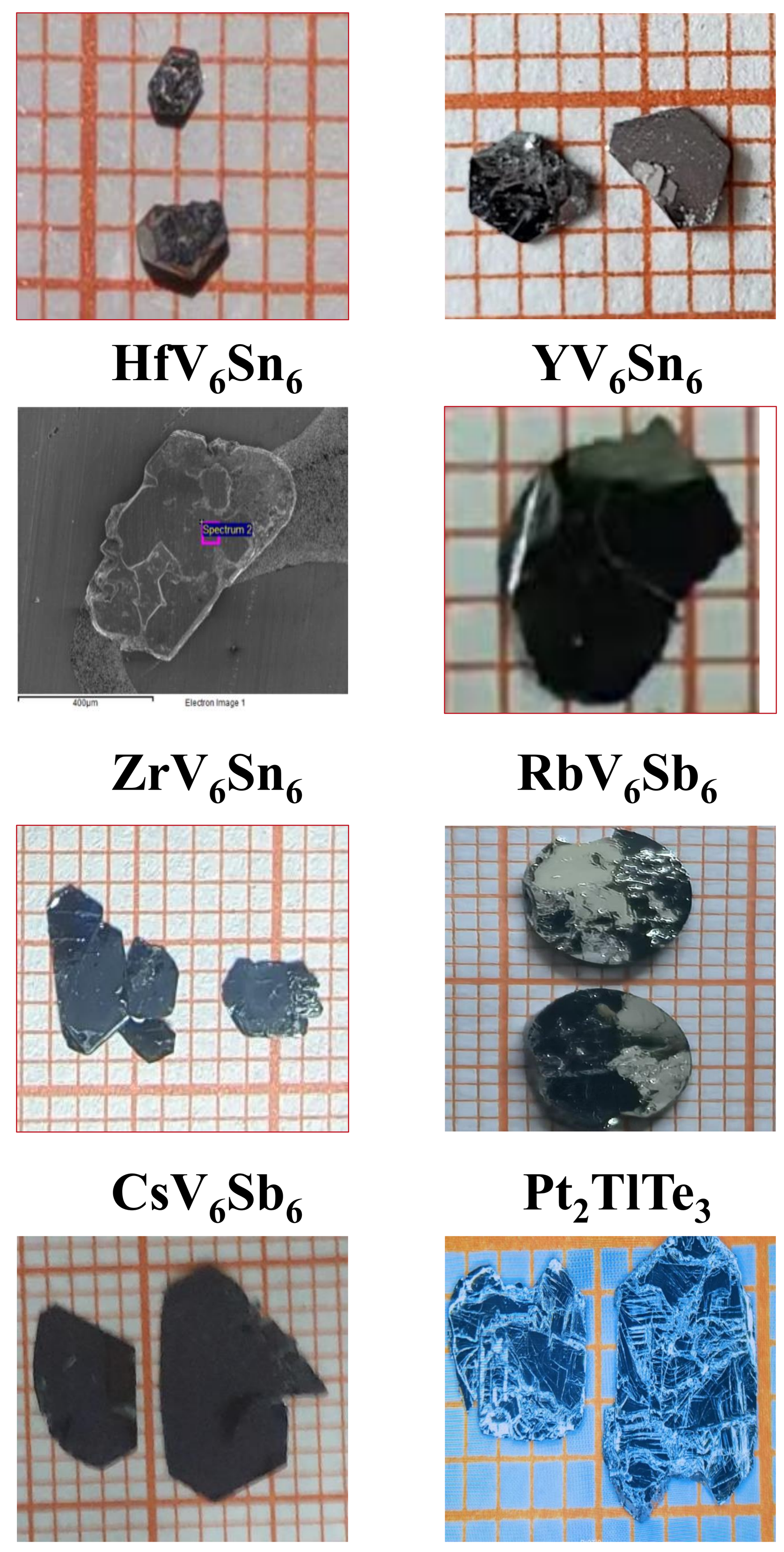
KV_3Sb_5 — RbV_3Sb_5 — CsV_3Sb_5 — $RbTi_3Bi_5$ — $CsTi_3Bi_5$ — $RbBi_2$

Kagome magnetic materials



$HfMn_6Sn_6$ — $ZrMn_6Sn_6$ — $GdMn_6Sn_6$ — GdV_6Sn_6 — $ZrFe_6Sn_6$

Other topological Kagome materials



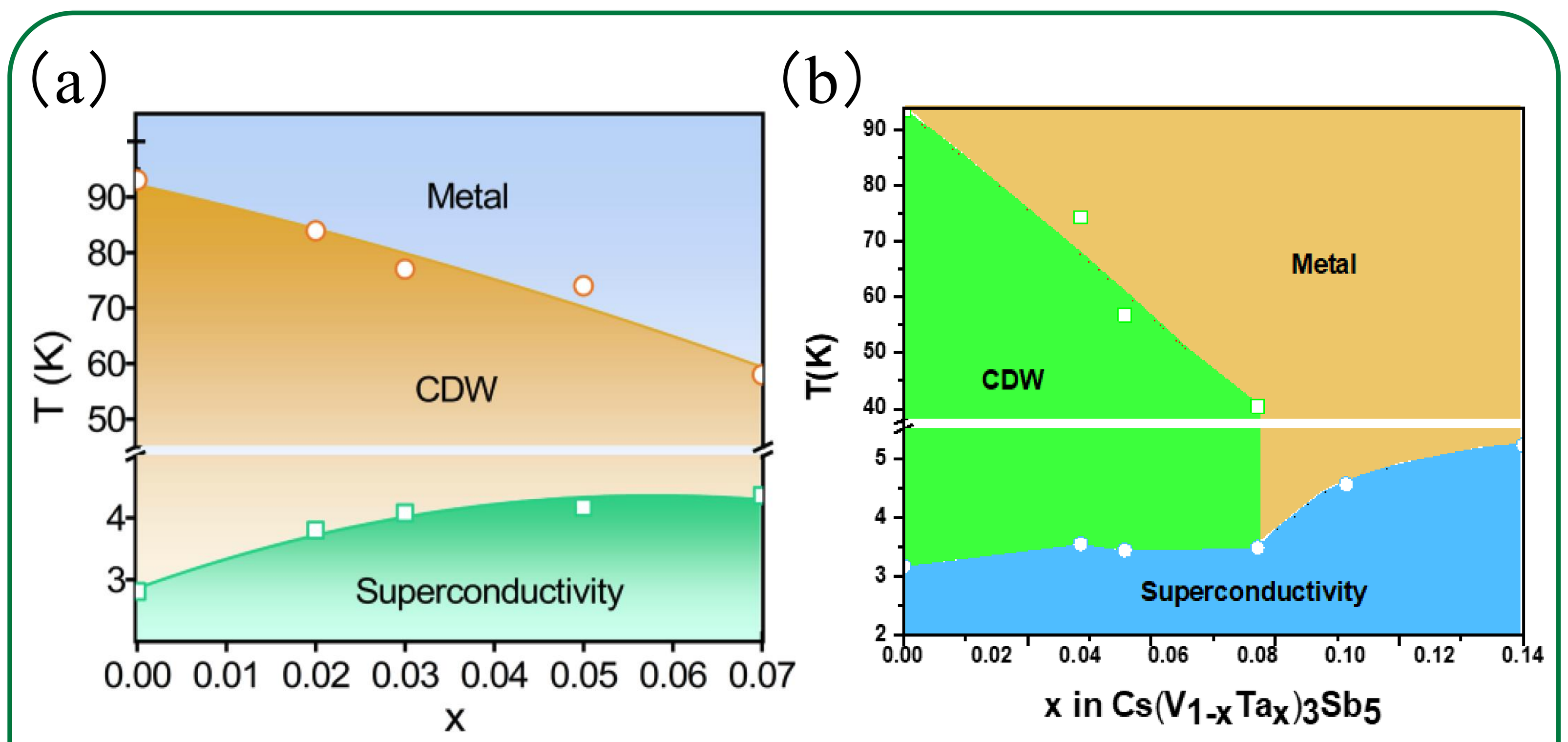
HfV_6Sn_6 — YV_6Sn_6

ZrV_6Sn_6 — RbV_6Sb_6

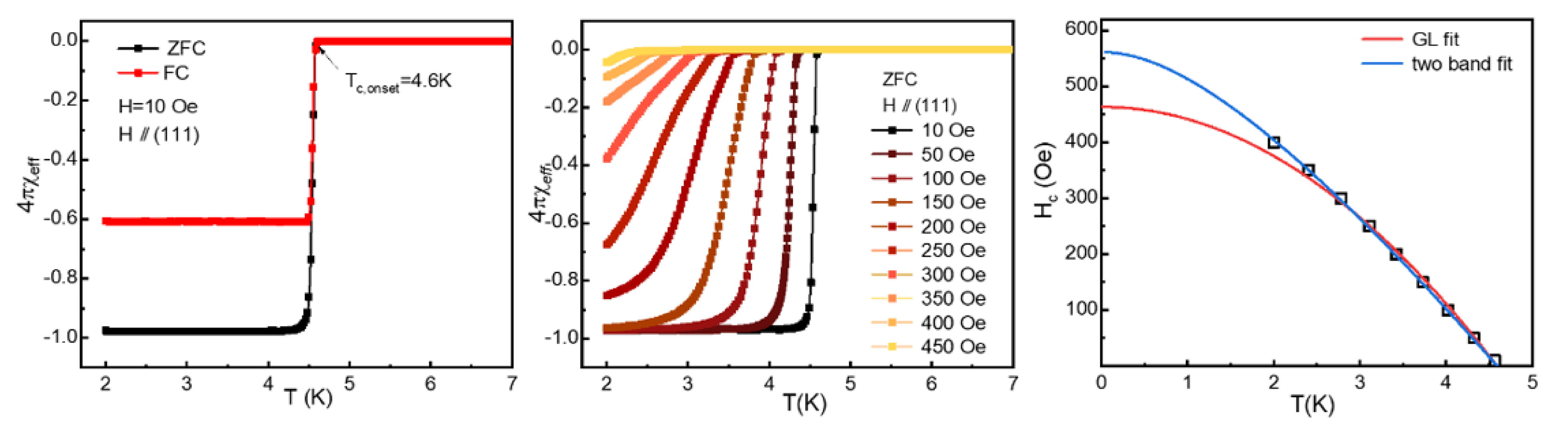
CsV_6Sb_6 — Pt_2TlTe_3

Nb_3Cl_8 — Pt_3Tl_2

Physical properties



Phase diagram of (a) $Cs(V_{1-x}Nb_x)_3Sb_5$ and (b) $Cs(V_{1-x}Ta_x)_3Sb_5$ single crystals



Superconductivity property of $CsBi_2$

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