Scientists develop colossal 3D electrical anisotropy of MoAlB single crystal

December 17 2021, by Zhang Nannan

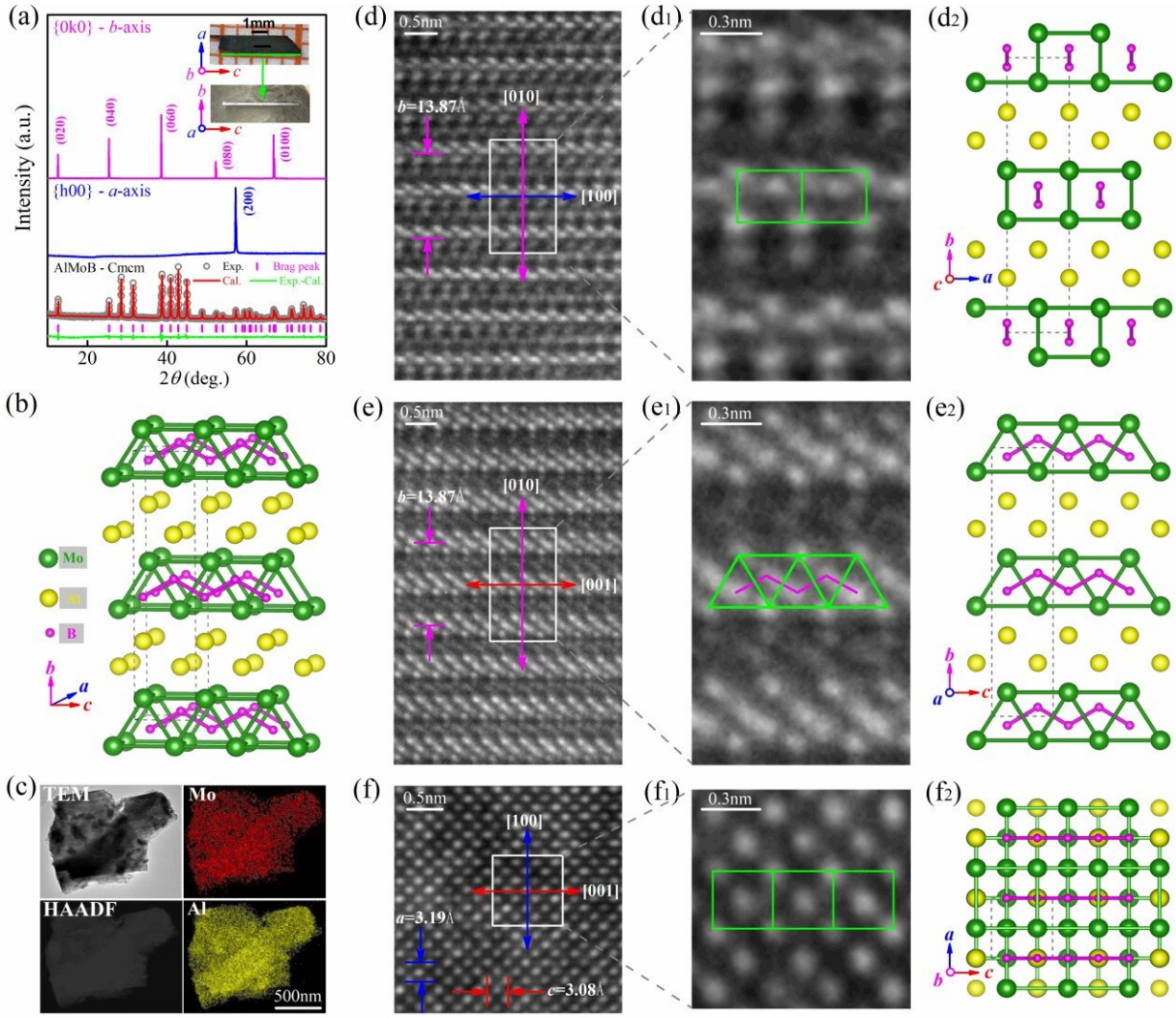

Fig. 1. 3D anisotropic crystal structure of MoAlB single crystal. Credit: Huang Yanan

Three-dimensional (3D) anisotropic functional properties of a single material (such as magnetic, electrical, thermal and optical properties, etc.) are not only conducive to the multi-use of materials, but also help to enrich the regulatory dimension of functional materials.

Researchers from the Hefei Institutes of Physical Science (HFIPS) of the Chinese Academy of Sciences (CAS) have successfully grown 3D layered MAB-phase MoAlB single crystal and discovered colossal 3D electrical anisotropy. Related results were published in *Small*.

They used aluminum as a cosolvent and prepared high-quality and large-sized MoAlB single crystals. In this process, they found, unexpectedly, the huge 3D conductivity anisotropy in MoAlB single crystal, which was larger than previously reported.

According to experimental and theoretical studies, the 3D structural anisotropy of MoAlB was confirmed by single crystal X-ray diffraction and transmission electron microscopy. 3D anisotropic electronic structure and chemical bond of MoAlB were confirmed by theoretical calculation.

Additionally, 3D anisotropic phonon vibration of MoAlB single crystal were observed in the measurement of Raman spectroscopy. Therefore, the origin of this huge 3D anisotropic electrical conductivity was mainly attributed to its 3D anisotropy of crystal and electronic structure.

This study opens a new way to find 3D anisotropic functional material in layered material systems with 3D anisotropy of crystal structure and chemical bond.

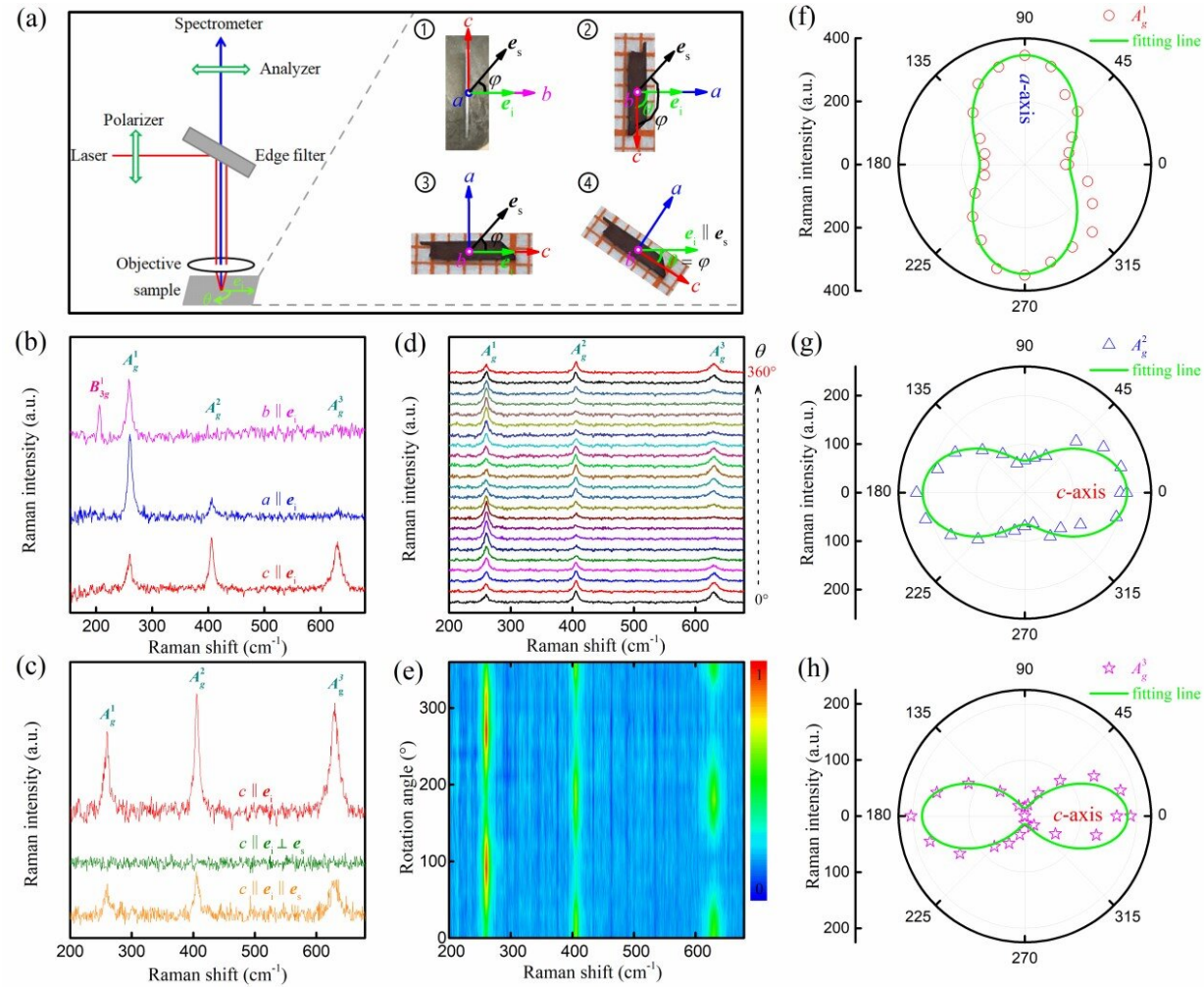

Fig. 2. 3D anisotropic phonon vibration of MoAlB single crystal. Credit: Huang Yanan

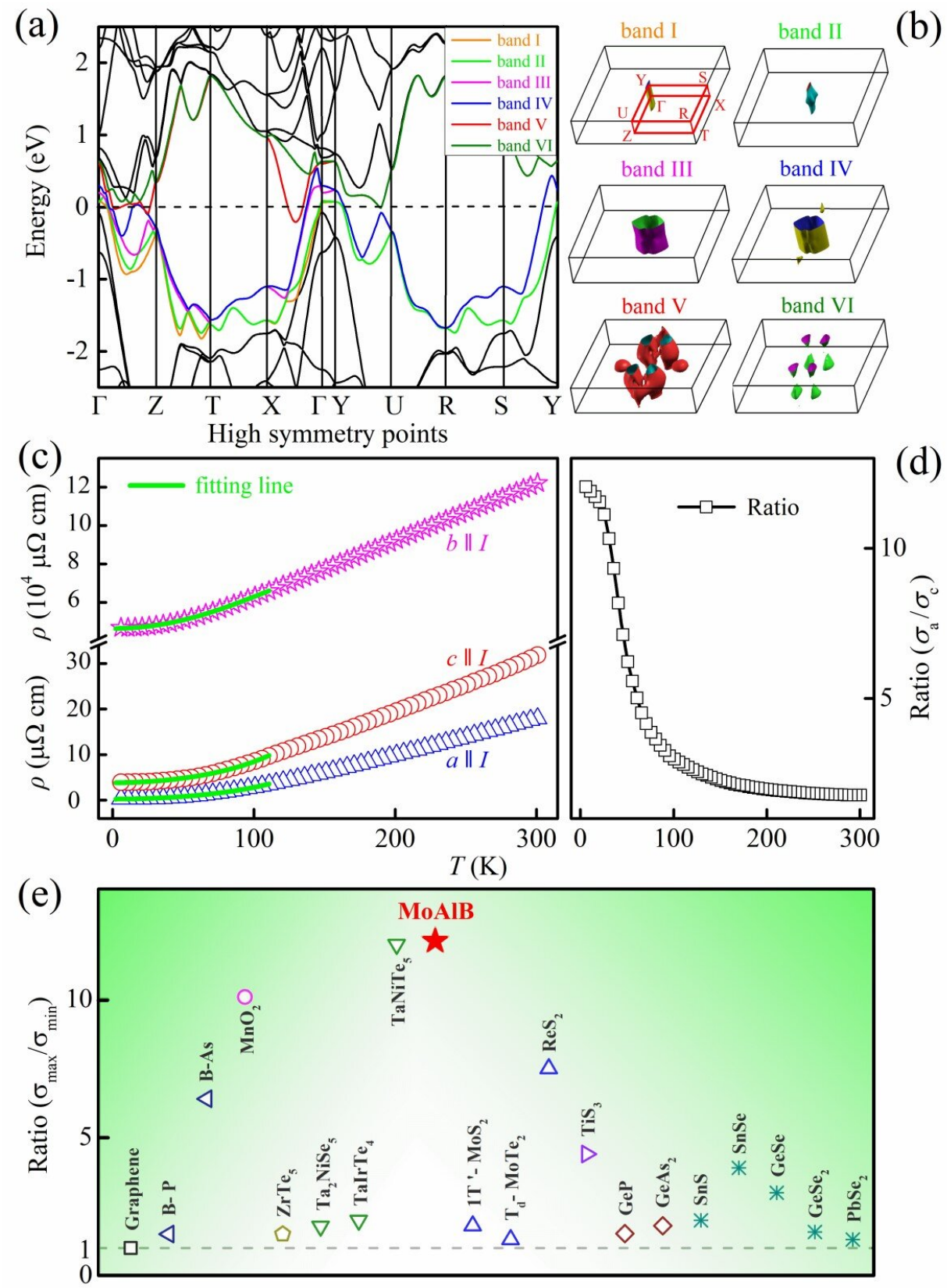
(a)
Energy (eV)
High symmetry points
Γ Z T X Γ Y U R S Y
band I
band II
band III
band IV
band V
band VI
(b)
(c)
fitting line
b ∥ I
c ∥ I
a ∥ I
ρ (10^4 μΩ cm)
ρ (μΩ cm)
T (K)
(d)
Ratio
Ratio (σa/σc)
(e)
MoAlB
Ratio (σmax/σmin)
Graphene
B- P
B-As
ZrTe5
Ta2NiSe5
TaIrTe4
MnO2
TaNiTe5
1T '- MoS2
Td- MoTe2
ReS2
TiS3
GeP
GeAs2
SnS
SnSe
GeSe
GeSe2
PbSe2

Fig. 3. 3D anisotropic electronic structure and electrical transport of MoAlB single crystal. Credit: Huang Yanan

More information: Yanan Huang et al, Colossal 3D Electrical Anisotropy of MoAlB Single Crystal, *Small* (2021). DOI: 10.1002/smll.202104460

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