Proximity-Effect-Driven Superconductivity in Two-Dimensional Bi Thin Films on Al(111)

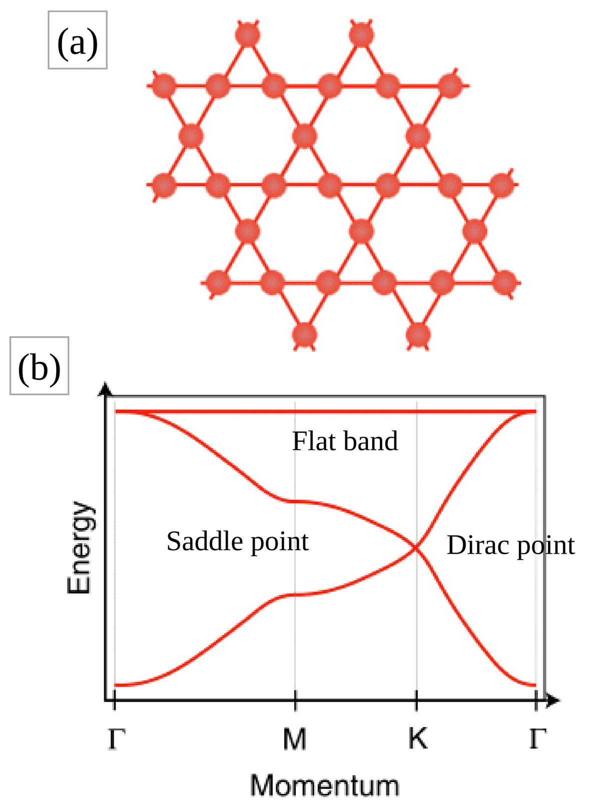
Kuan-Ying Sung (宋冠穎)[1*], Nitin Kumar[1], Deepan Beja[1], Yu-Yao Su (蘇煜堯)[1], Gustav Bihlmayer[2], Pin-Jui Hsu (徐斌睿)[1,3]

[1]*Department of Physics, National Tsing Hua University, Hsinchu, Taiwan*
[2]*Peter Grünberg Institut and Institute for Advanced Simulation, Forschungszentrum Jülich and JARA, D-52425 Jülich, Germany*
[3]*Center for Quantum Technology, National Tsing Hua University, Hsinchu, Taiwan*

* Presenter: Kuan-Ying Sung, Email: fun970610@gmail.com

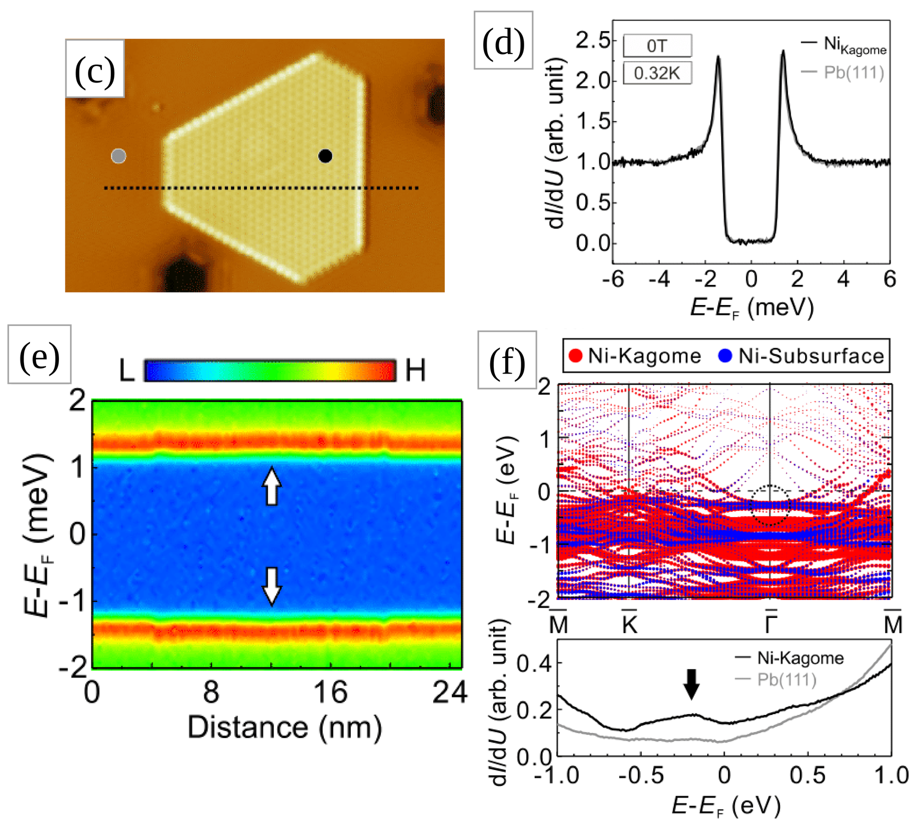
Introduction

Kagome structure



- The Kagome lattice is a 2D structure with corner-sharing triangles.
- The band structure shows flat band, saddle points, and Dirac point.

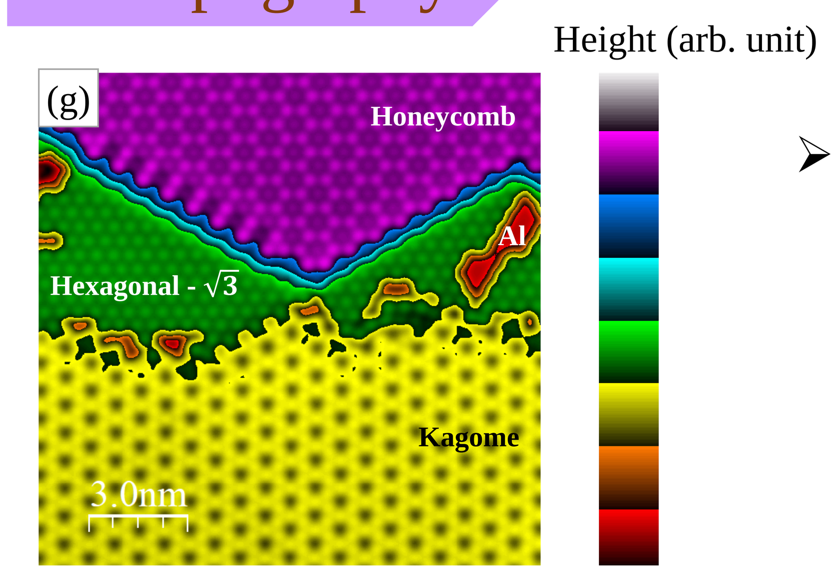
Literature review



- An enhanced superconducting gap on Ni-Pb Kagome.
- STS measurement and DFT calculation show flat band on Ni-Pb Kagome.

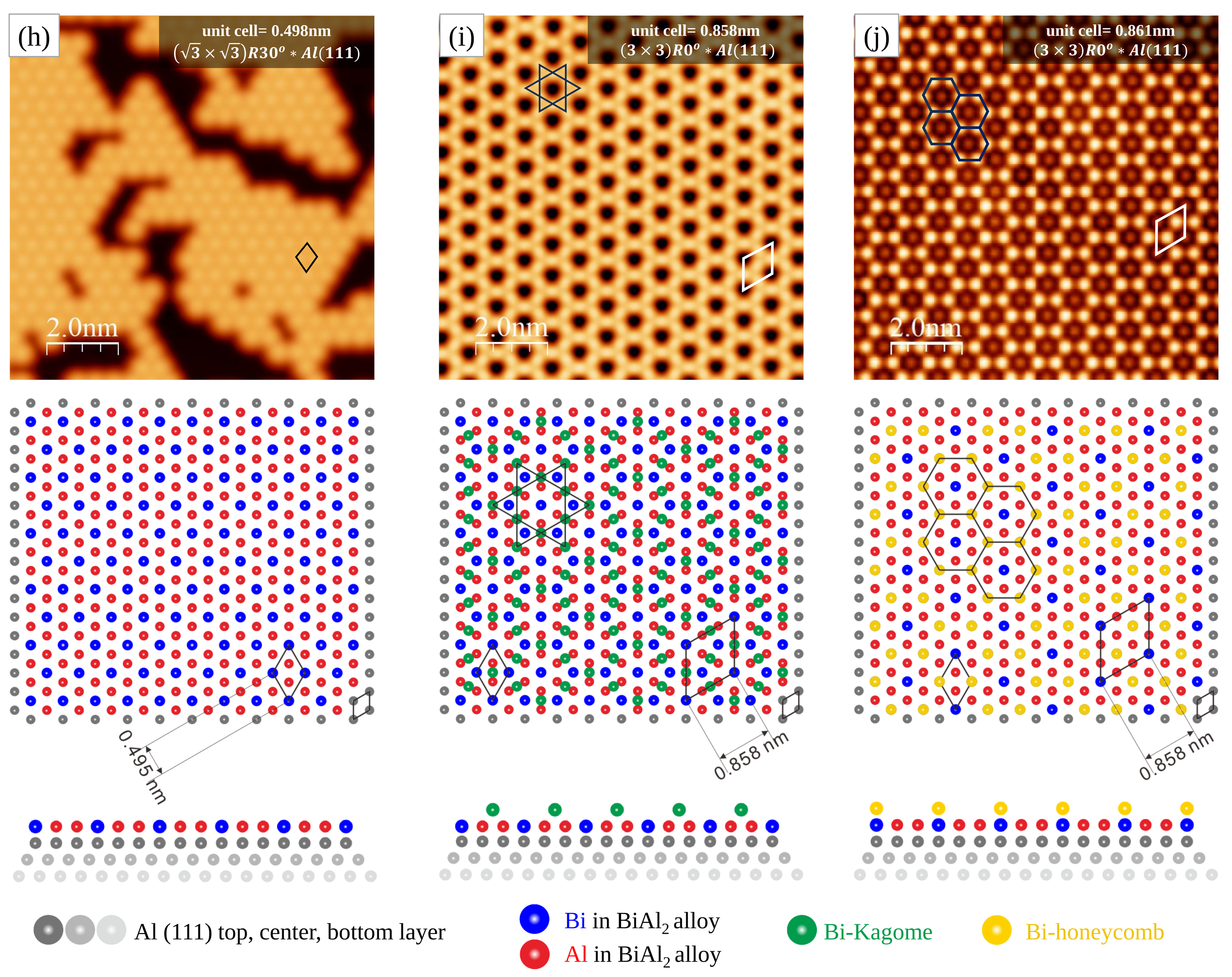
Results and Discussion

Topography

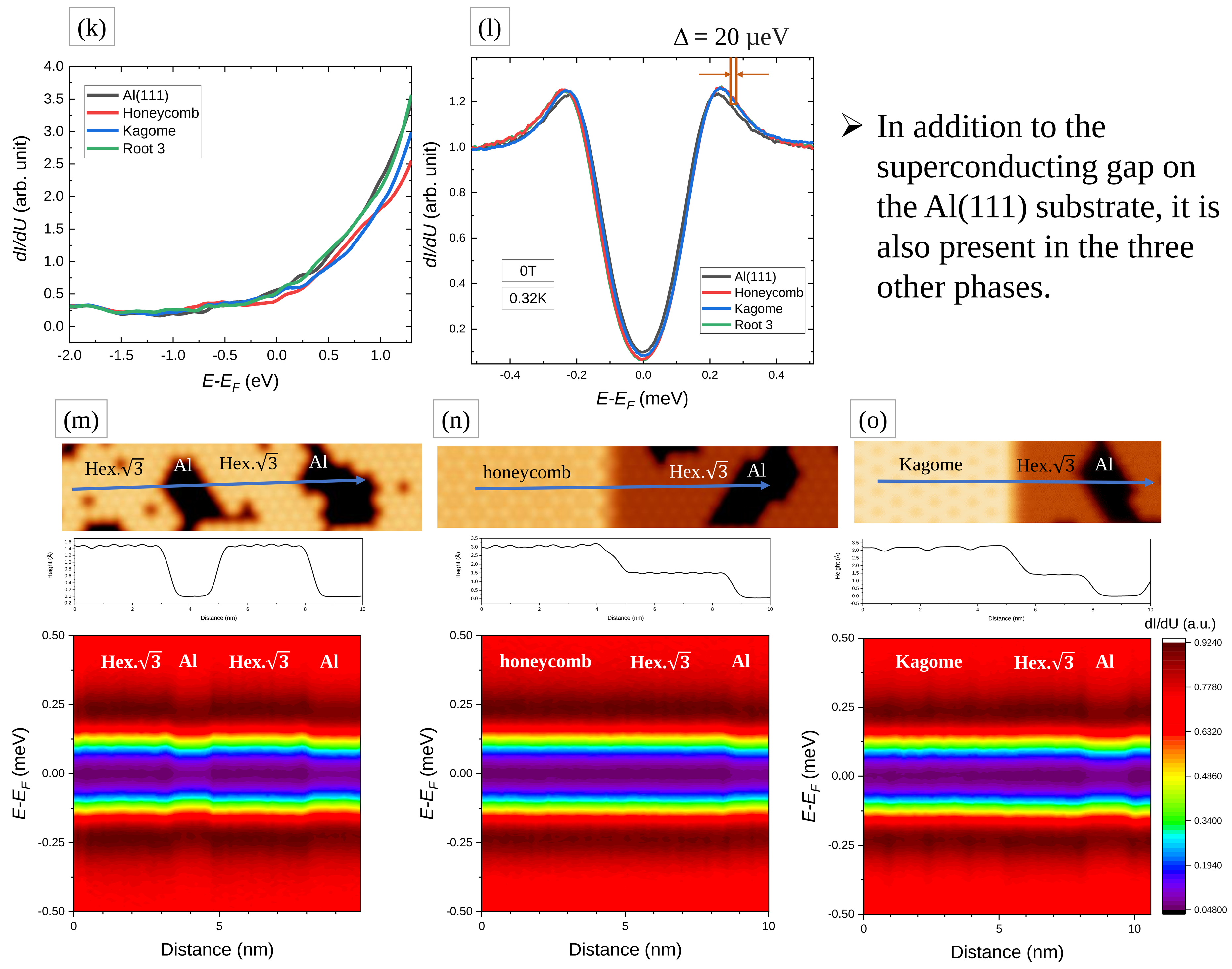


- The atomic structure consists of three phases: hexagonal $(\sqrt{3} \times \sqrt{3})R30°$, Kagome-$(3 \times 3)$, and honeycomb-$(3 \times 3)$ with respect to the (1×1) unit cell of Al(111), where the lattice constant is 0.286 nm.

Structural model



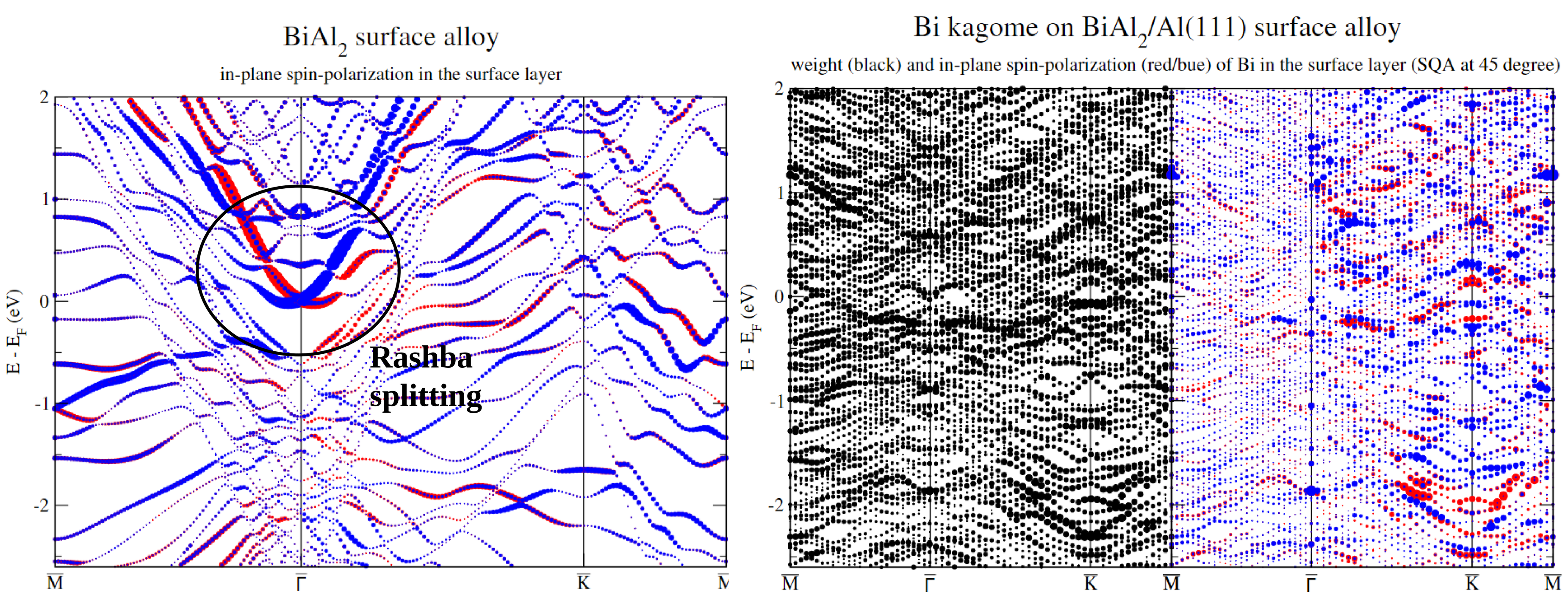
STS

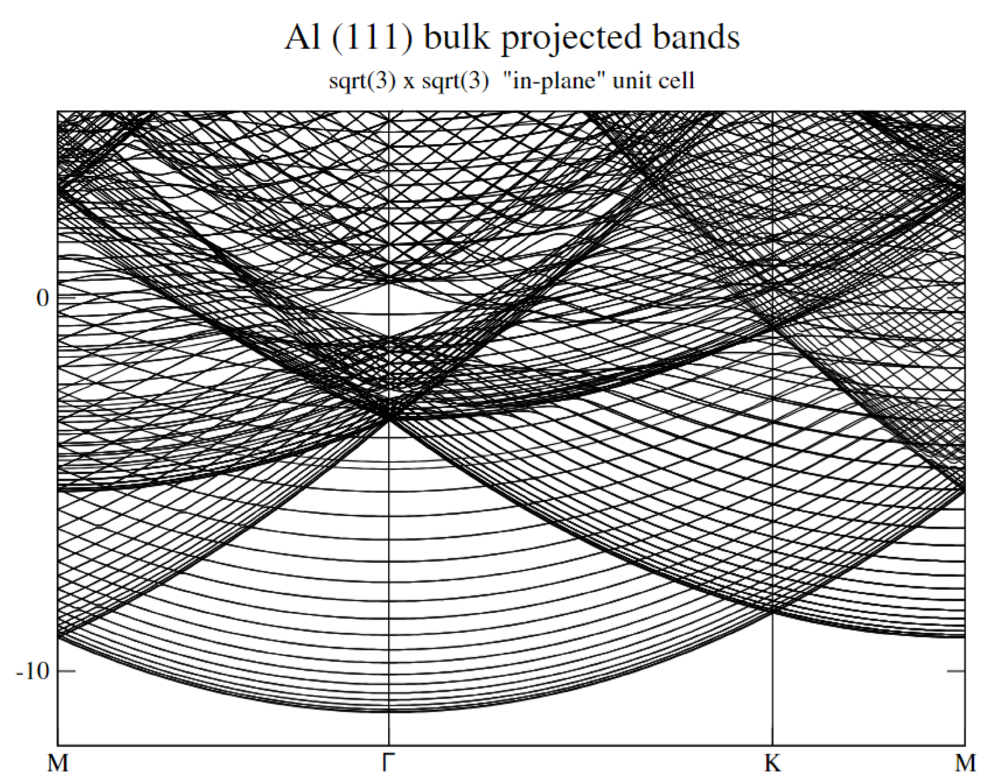


- In addition to the superconducting gap on the Al(111) substrate, it is also present in the three other phases.

- An enhanced superconducting gap on hexagonal $(\sqrt{3} \times \sqrt{3})R30°$, Kagome, and honeycomb lattice have been mapped out by line spectroscopy measured along the blue arrow in the respective topography in the figure m~o.

DFT calculation





- From density functional theory calculations, it is evident that the surface alloy exhibits a distinct Bi state but above the Fermi level.
- Additionally, Rashba splitting phenomenon is observed in the surface alloy, where the energy bands exhibit a clear splitting.

Summary

1. We have successfully grown Bi/Al(111) with three distinct phases, hexagonal $(\sqrt{3} \times \sqrt{3})R30°$, Kagome -$3 \times 3$ and honeycomb-3×3, respectively.
2. Through DFT calculations, we can accurately construct a structural model that includes the correct formation of $BiAl_2$.
3. Line dI/dU spectra from hexagonal $(\sqrt{3} \times \sqrt{3})R30°$, Kagome and honeycomb phases to Al(111) substrate show enhancement of the superconducting gap.

Reference

[1] T. Neupert, M. M. Denner, J.-X. Yin, R. Thomale, M. Z. Hasan, Nat. Phys., 18, 137 (2022).

[2] Y.-H. Lin, C.-J. Chen, N. Kumar, T.-Y. Yeh, T.-H. Lin, S. Blügel, G. Bihlmayer, P.-J. Hsu, Nano Lett., 22, 8475 (2022).