

Interface Enhanced Superconductivity in FeSe/SrTiO₃ Heterostructures

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In this presentation I will show our recent study on interfacial two-dimensional electron gas and charge transfer across one and a few unit-cell thick FeSe films grown on SrTiO₃ substrate at 10K [1]. The approach allows us to directly observe interfacial atomic arrangement and valence states above and below superconducting critical temperature, T_c . Combined with Green's function based FEFF simulations as well as electric transport measurements and backgating with a positive potential on SrTiO₃, we were able to reveal the origin of the ten-time enhancement of T_c of the monolayer FeSe films compared to its bulk counterpart. Our study supports the model of electron-phonon coupling across interface as the mechanism for high T_c since the positive potential tends to 'pull' the interfacial electrons closer to the high Debye temperature SrTiO₃ phonon bath. The ability of atomically resolved imaging and EELS mapping at ultralow temperatures can be a powerful tool for the study of other emergent quantum phenomena related to interfaces and defects in functional materials. If time allowed, I will also report our recent electromagnetic biasing experiments at low temperatures (10-20K) on chiral spin texture materials that have a non-trivial topology to reveal the transitions mechanism of helical and skyrmion phases using a quantitative phase-retrieval method we developed recently [2].

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References

[1] W. Zhao, et al., "Direct Imaging of Electron Transfer and Its Influence on Superconducting Pairing at FeSe/SrTiO₃ Interface", *Science Advances*, 4 eaao2682 (2018).

[2] Garlow, J.A., "Quantification of mixed Bloch/Néel topological spin textures stabilized by the Dzyaloshinskii–Moriya interaction in Co/Pd multilayers", *Phys. Rev. Lett.*, 122, 237201 (2019).