IAS Focused Program on Reticular Quantum Matter (Nov 30 - Dec 4, 2026) -
Poster Presentation/ Contributed Talk

Strong Electron Correlation Phenomenon in Reticular Matters

Qingyun Wan

Chemistry Department, The Chinese University of Hong Kong, Hong Kong SAR

Email: qingyunwan@cuhk.edu.hk

Electron pairing mechanisms govern the emergence of correlated phases such as charge-density waves (CDWs), Mott insulating states, and superconductivity in low-dimensional materials. However, controlling these pairing pathways—particularly suppressing Peierls instabilities in one-dimensional (1D) metal–halide chains—remains challenging without external pressure or chemical doping. Here we demonstrate two complementary molecular-level strategies that leverage intrinsic periodic electrostatic potentials of reticular matters to reconfigure electron correlations in Pt–halide chains.

In the first system,[1] a double-chain molecular superlattice, $[PtI(en)_2]_2[PtPOP\text{-}I]$, enforces strong interchain electrostatic coupling between alternating Pt–I MX chains and Pt–Pt–I–I MMXX chains. This coupling shifts the electron pairing mechanism from conventional localized Pt(II)/Pt(IV) mixed valency to a delocalized Pt(III) multisite pairing pathway, stabilizing the first iodide-bridged Pt(III) CDW chain. Raman spectroscopy, XPS, and crystallography confirm Pt-centered lattice distortion and a delocalized Pt(III) ground state.

In the second system,[2] Pt–I chains are confined within ordered Cu–I porous nanochannels, forming a Pt-I@MOF-like superlattice (**Figure 1**). The periodic electrostatic field generated by the anionic Cu–I framework suppresses Peierls instability, yielding equal Pt–I bond lengths, an averaged Pt(III) oxidation state, and the disappearance of Raman-active Pt–I stretching modes. Electrical measurements reveal a ~4-order-of-magnitude conductivity enhancement (4.3×10^{-2} $S\cdot cm^{-1}$), demonstrating that confinement-induced electrostatic modulation can effectively eliminate Peierls instability in 1D Pt–halide chains.

Together, these results establish periodic electrostatic-potential engineering—via molecular superlattices or porous frameworks—as a powerful and generalizable strategy for manipulating electron pairing, suppressing lattice instabilities, and accessing high-mobility correlated states in low-dimensional electronic materials.

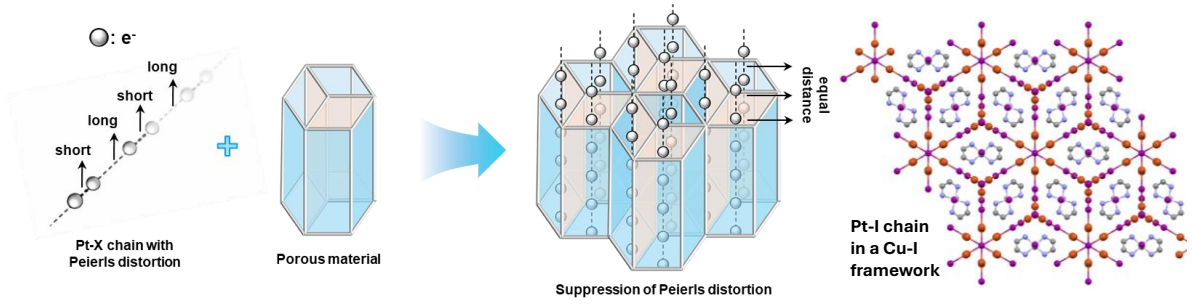


Figure 1. (left) Schematic drawing showing the encapsulation of Pt–X chains within a porous material, leading to the suppression of the Peierls distortion. (right) Single-crystal structure of the $[PtI(en)_2]_3(CuI_4)_2CuI$.

References:

[1] Luo, Y.; Zhou, N.; Zhang, Y.; Tan, Y.F.; Yang, Y.; Wang, X.; Wan, Q.* Tailoring the Electron Pairing Process in a Pt–I Charge-Density-Wave Chain. ***J. Am. Chem. Soc.*** 2026, 148, 30466-30475. https://doi.org/10.1021/jacs.6c09941

[2] Zhou, N.; Zhang, Y.; Tan, Y.; Wan, Q.* Suppression of Peierls Instability in a Metal–Halide Porous Framework. ***Angew. Chem., Int. Ed.*** 2026, just accepted. DOI: 10.1002/anie.7724982.

End of Form