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"Band-Structure Engineering" of Quantum Materials to Create a new Superconductor

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Materials-by-design commonly starts with first principles theory to identify materials with desired properties. The significant energetic contribution of electron-electron interactions, however, makes it difficult for theory to accurately predict quantum materials. Experimental tools like ARPES that measure electronic band structure directly used in combination with synthesis tools like MBE make it possible to enter the materials-by-design loop from a different on-ramp and navigate quantum materials to achieve desired properties.

Using epitaxial strain, PARADIM's in-house research team transmuted a metal into a superconductor for the first time. With their unique tools, PARADIM scientists were able to apply strain in different directions to a thin film of RuO_2 and using ARPES follow its effect on the band structure. The RuO_2 remained metallic, but a band with a high density of states could be moved close to the Fermi level. When this occurred, the RuO_2 became superconducting. The ability to deterministically enhance the superconducting transition temperature by design, rather than by serendipity, has been a long sought-after goal in condensed matter physics and materials science. PARADIM's approach can be expanded to various related quantum materials, particularly other oxide quantum materials.

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