Discovery of high-Tc superconductivity in a nickelate under pressure

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High-transition-temperature (high-Tc) superconductivity in cuprates has been discovered for more than three decades, but the underlying mechanism remains a mystery. Cuprates are the only unconventional superconducting family that hosts bulk superconductivity with Tcs above the liquid nitrogen boiling temperature at 77 Kelvin. We found superconductivity in single crystals of La3Ni2O7 grown by the high-pressure floating zone method with a maximum Tc of 80 K at pressures between 14.0-43.5 gigapascals [1,2]. Our collaborators have confirmed the high Tc superconductivity on our samples independently [3-5]. The superconducting phase under high pressure exhibits an orthorhombic structure of Fmmm space group with the 3dx2-y2 and 3dz2 orbitals of Ni cations strongly mixing with oxygen 2p orbitals [2,6]. Density functional theory calculations suggest the superconductivity emerges coincidently with the metallization of the ÏČ-bonding bands under the Fermi level, consisting of the 3dz2 orbitals with the apical oxygens connecting Ni-O bilayers. ARPES and infrared measurements are consistent with our theoretical expectations [7,8]. Thus, the discoveries not only reveal important clues for the high-Tc superconductivity in this Ruddlesden-Popper double-layered perovskite nickelates but also provide a new family of compounds to investigate the high-Tc superconductivity mechanism. Indeed, La4Ni3O10 has also been found superconductivity below 20 K under pressure. The new progresses in the studies of nickelate high Tc superconductors will be introduced.

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