**Pressure-driven structure phase transitions and emergent superconductivity in ReO3**

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Abstract text:

As an *A*-site-vacant perovskite-type oxide, ReO3 undergoes successive pressure-driven structural phase transitions with the rotations of ReO6 octahedra. In this work, we first verified the structural phase transitions in ReO3 through detailed high-pressure X-ray diffraction and electrical transport measurements. The dome-shaped superconducting phase emerges in the rhombohedral-I phase which is characterized by a lattice of an almost tightly packed oxygen layer inserted into the Re cation layer and shows the optimal *T*c ~ 17 K at about 30 GPa. Combined with first-principles calculations, we found that the density of states near the Fermi level displays obvious increase, and the low-frequency vibration associated with the hexagonal densely packed oxygen lattice significantly enhances the electron-phonon coupling compared with ambient pressure, which is responsible for the observed superconductivity with a relatively high *T*c. The present work establishes a rare case with the highest *T*c in 5d transition metal oxides and provides an important clue for further exploring new oxide superconductors with high *T*c at ambient pressure by employing high-pressure synthesis or heterostructure engineering.