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LETTER

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Copper oxides are the only materials that show transition temperatures, T_c, above the boiling point of liquid nitrogen, with a maximum T_c^m of 162 K under pressure. Their structure is layered, with one to several CuO_2 planes, and upon hole doping, their transition temperature follows a dome-shaped curve with a maximum at T_c^m. In the underdoped regime, i.e., below T_c^m, a pseudogap T^* is found, with T^* always being larger than T_c, a property unique to the copper oxides.[1] In the superconducting state, Cooper pairs (two holes with antiparallel spins) are formed that exhibit coherence lengths on the order of a lattice distance in the CuO_2 plane and one order of magnitude less perpendicular to it. Their macroscopic wave function is parallel to the CuO_2 plane near 100 % d at their surface, but only 75 % d and 25 % s in the bulk, and near 100 % s perpendicular to the plane in YBCO. There are two gaps with the same T_c [2]. As a function of doping, the oxygen isotope effect is novel and can be quantitatively accounted for by a two-band vibronic theory [3] near T_c^m, and underdoped below it till $T_c = 0$ by a formula valid for (bi)polarons [4]. These cuprates are intrinsically heterogeneous in a dynamic way. In terms of quasiparticles, Jahn Teller bipolarons are present at low doping, and aggregate upon cooling [1], so that probably ramified clusters and/or stripes are formed, leading to a more Fermi-liquid-type behavior at large carrier concentrations above T_c^m.

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[1] For an overview see [1].

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