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New electronic perovskite oxides from beyond high pressure synthesis

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Materials synthesised from high pressure (HP) conditions offer a variety of possibilities for the discovery of new electronic and magnetic phenomena. Recovery of a solid to ambient pressure (AP) from its HP thermodynamic stability field effectively introduces a large negative pressure that can drive the material into an unusual electronic ground state; as illustrated by HP structural and property studies of PbRuO3 and BiNiO3. PbRuO3 is synthesised at 10 GPa and shows an orbitally ordered phase at AP and low temperatures that is suppressed at an apparent quantum critical point near 6 GPa [1]. A new structural phase emerges at much higher pressures ~30 GPa. BiNiO3 synthesised at 6 GPa shows an unusual charge order that is suppressed at 3.4 GPa; the transition is associated with a volume collapse leading to colossal negative thermal expansion [2]. Materials recovered from HP are also precursors for 'hard-soft' chemistry, where the instability of a dense precursor from 'hard' HP conditions is relieved through 'soft' post-synthesis modification. We recently demonstrated this concept for the HP phase SrCrO3 which on reduction gives two new phases SrCrO2.80 and SrCrO2.75 with long period oxygen vacancy, charge and spin ordered superstructures [3]. These studies have been carried out in collaboration with co-authors of the papers below.

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