Novel Electronically Conducting Tellurium Oxides

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Tellurium oxides seldom show measurable electronic conductivity. Tellurium oxides that appear to have Te\(^{5+}\) contain Te\(^{4+}\) and Te\(^{6+}\) in two distinct crystallographic sites and are electronic insulators. Here we report on the synthesis and characterization of several new tellurium rich oxides of the general formula, CsM\(_x\)Te\(_{2-x}\)O\(_6\), crystallizing in modified pyrochlore structure. Most of the compounds reported here are black in color with some exhibiting good electronic conductivities (2 S/cm) and Seebeck measurements indicate all are n-type. The observation of high electronic conductivities in compounds like CsGe\(_{0.5}\)Te\(_{1.5}\)O\(_6\), CsAl\(_{0.33}\)Te\(_{1.67}\)O\(_6\) confirms that observed conductivity is arising from doping of electrons into the empty 5s orbitals of Te\(^{6+}\). This reduction is apparently accompanied with some small deviation from the ideal formula: oxygen content and/or ratio of cations on octahedral sites. This is inconsistent with single-crystal X-ray as well as powder neutron diffraction structure refinements and the observed sign of the Seebeck coefficient. To our knowledge, this is a first observance of high electrical conductivity in mixed valent tellurium oxides.

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