What are high entropy ceramics and what are they good for?

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Disorder has long been a tool in changing mechanical, electronic, and other physical properties of materials. However, the amount of control is regularly limited by the enthalpy of formation for high concentrations of dopants/adatoms. As a mechanism to overcome this limitation, high entropy ceramics increase the number of elements on lattice sites – thereby lowering the overall Gibbs free energy of formation by increasing the configurational entropy of the system. Using this method, theoretical and experimental results exploring the role of disorder at this scale in manipulating spin, charge, lattice and electronic order parameters will be discussed. First, in exploring magnetism, electronic structure and valence of the high entropy ABO_3 perovskite $La_{1-x}Sr_x(Cr_{0.2}Mn_{0.2}Fe_{0.2}Co_{0.2}Ni_{0.2})O_3$. Second, in an experimental realization of extreme *A*-site cation disorder in $(Y_{0.2}La_{0.2}Nd_{0.2}Sm_{0.2}Gd_{0.2})NiO_3$, whose parent ternary oxides each have a large range of electronic (metal to insulator transition) and structural phase transition temperatures. In exploring these systems, it is revealed that disorder on this scale can suppress or favor certain order types, create phase frustration, and be used to design a desired phenomena not accessible by conventional materials design methods.

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