

Structure-property relationships in superconductors with honeycomb layers

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In this work we successfully synthesized $\text{Ca}_{1-x}\text{Sr}_x\text{AlSi}$ and $\text{Ca}_{1-x}\text{Sr}_x\text{GaGe}$ solid solutions and investigated the structural and superconducting properties of these systems. Both CaAlSi and CaGaGe crystallize in 6-folded layered structures with slightly buckled Al-Si and Ga-Ge honeycomb layers. The end members, SrAlSi and SrGaGe , crystallize in prototypical AlB_2 -type structures with planar Al-Si and Ga-Ge honeycomb layers, respectively. We observed how structure and electronic properties change with chemical substitution, and we find that with an increasing Sr content the Al-Si and Ga-Ge layers become planar in both solid solutions. Interestingly, while the two systems behave chemically very similar, they display very different electronic properties. We find that the buckling of the honeycomb layers in $\text{Ca}_{1-x}\text{Sr}_x\text{AlSi}$ enhances the superconducting critical temperature across the solid solution, while it decreases it in the $\text{Ca}_{1-x}\text{Sr}_x\text{GaGe}$ system.