X-ray Diffraction Studies of two Germanium $Sr_8Ga_{16}Ge_{30}$ and $Cs_8Na_{16}Ge_{136}$ Clathrates: Promising Candidates for Thermoelectric Applications

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X-ray diffraction patterns of Type I (semiconducting $Sr_8Ga_{16}Ge_{30}$) and Type II (metallic $Cs_8Na_{16}Ge_{136}$) clathrate compounds have been prepared using the X-ray Rietveld refinement technique. These compounds feature zeolite-like open structures, and have potential thermoelectric applications. The type I $Sr_8Ga_{16}Ge_{30}$ compound crystallizes in *Pm-3n* with a = 10.73377(8) Å, and the type II $Cs_8Na_{16}Ge_{136}$ phase is also cubic with space group *Fd-3m* and a = 15.48463(38) Å. The frameworks of these compounds are characterized by covalent tetrahedrally-bonded (Ge,Ga) or Ge atoms, which form polyhedral cages inside which the alkali/alkaline-earth metals are located. While the sizes of the two cavity types in the Type I structure are similar, they are significantly different in the Type II structure. X-ray powder diffraction patterns of these two compounds have been submitted to ICDD to be included in the Powder Diffraction File. The structure of $Na_{1-x}Ge_3$ which often coexists with the type-II clathrate Na_xGe_{136} phase during the synthesis process will also be discussed.