Substitutional Disorder in Gallogermanate like Crystals

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The substitutional disorder occurs when two or more cations can occupy, with well defined probabilities different positions in the lattice. The mean stoichiometry is preserved, but, depending on the ions distribution on sites, local crystalline fields have various values. Such variation can be put in evidence by spectroscopic measurements, sensitive to the value and crystalline field symmetry. Such disorder is frequently encountered in solid state. We shall concentrate upon one crystal from this class, langatate, LGT. Its formula is $La_3Ga_{5.5}Ta_{0.5}O_{14}$. There are 4 cationic positions in this lattice, dodecahedral distorted Thomson cube (3e, occupied by La^{3+}), octahedral (1a-O_h, occupied with equal probabilities by Ga^{3+}/ Ta^{5+}), and 2 tetrahedral positions (3f and 2d, occupied by Ga^{3+}). The disorder is due to the distribution of Ga and Ta ions on the octahedral positions. That is one of the simplest cases. The general symmetry is trigonal with P321 space group. Two techniques will be used to put in evidence this disorder: Electron Paramagnetic Resonance, EPR, of Cr^{3+} ions introduced as an impurity in the crystal. This ion occupies preferentially the octahedral position. It feels the disorder induced by the next neighbor Oh positions. The second technique is the fluorescent spectroscopy of Eu^{3+} ions. This rare earth ion enters in the 3e position; the dodecahedral and octahedral positions are in the same planes, perpendicular on the trigonal axis. Broadening and splittings of the resonance lines are discussed in terms of the different local crystalline fields.