Quasicrystals in the Zn-Mg-RE System: Growth and new phases

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Quasicrystals are long-range ordered but non-periodic solid-state materials. They show sharp diffraction peaks with „forbidden“ symmetries in the patterns, as 5- or 10-fold rotational symmetry. They can be understood as a projection of a 6-dimensional periodic lattice into 3-dimensional real space. The zinc-magnesium-rare-earth quasicrystals are interesting candidates to investigate magnetic properties in an aperiodic lattice because of the localized magnetic moments due to the 4f electrons of the rare earth atoms. For single crystal growth, a suitable melt composition has to be used, from which the quasicrystal solidifies primarily. The centimeter-sized high quality single crystals are grown by the liquid encapsulated top seeded solution growth method (LETSSG) under argon atmosphere from an aluminia crucible, using a water-cooled tungsten tip as a seed. A eutectic LiCl/KCl mixture which is added to the educts prevents the zinc from evaporation at growth temperature. Single quasicrystals have been grown of the face-centred icosahedral $Zn_{60}Mg_{30}RE_{10}$ compound using the rare earths holmium, erbium and yttrium and from the new well-ordered simple icosahedral $Zn_{75}Mg_{14}Ho_{11}$ phase. It is also shown that for the latter material holmium can be replaced by the rare earths erbium and thulium. For many other rare earths a rombohedral phase forms instead of the quasicrystal. The reason is discussed as a space problem in the two different structures.