Crystal growth of candidate materials for topological Kondo semimetals

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Topological Kondo semimetals (TKS) are materials where correlation-driven topological metallic states are realized. Recently, based on an interplay of strong electron correlations with the space group symmetry a general approach for TKS material design was developed. Based on this theoretical approach two groups of materials – Ce and Pr compounds - were identified as candidates for TKS [1,2]. The TKS displays unique physics. However, proving their topological nature and unveiling the low temperature properties characteristic of TKS are possible only in crystals of the highest quality.

In this paper, we report on results of crystal growth experiments of these compounds. The focus of our investigations was on the relationship between growth technique, composition and physical properties. For $CeRh_2Ga_2$ and $Ce_2Au_3In_5$ these were the first attempts for single crystal growth, whereas the $CePt_2Si_2$ growth was reported earlier. However, a revision of the latter with emphasis on the crystal stoichiometry was necessary. A number of Pr compounds, which are expected to be non-Fermi liquid topological phases, are investigated regarding the crystal growth feasibility and crystal quality.

Phase relations relevant to crystal growth were investigated by differential thermal analysis (DTA). The quality of crystals obtained by various growth techniques (flux, Bridgman, Czochralski, floating zone) was investigated by X-ray powder/single crystal diffraction and scanning electron microscopy with energy dispersive spectroscopy (SEM/EDX). Measurements of the physical properties that are indicative of TKS (e.g., T^2 specific heat with a huge pre-factor Γ for nodal-line Weyl-Kondo semimetal, spontaneous Hall effect) are reported. They provide first direct experimental evidence for the theoretical prediction for some of the candidates.

References

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