Crystal structure of $EuZn_2X_2$ Zintl phases in elevated pressure

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Abstract

$EuZn_2P_2$ and $EuZn_2As_2$ belong to the family of the Zintl-like phases being recently is in the focus of interest with respect to magnetic and transport properties [1,2]. Materials belonging to this group of Zintl phases (ionic entities covalently bonded) have been studied since several decades for their chemical properties. Their (ambient-pressure) structure was characterized, but the point of view of electronic properties became subject of interest rather later. Incorporating magnetic ions in these compounds represents the opportunity to study the interplay of magnetic degrees of freedom and electronic structure. Upon the pressure application the systems can undergo either increase of magnetic ordering, change of the type of transition, change of the crystal structure or insulator-metal transition.

Our recent interest in magnetic and transport properties of the Zintl phases has a special focus in the development of their behavior upon application of pressure [1,3] with variations of the lattice properties, namely the magnetic-entities distance variations. The transport and magnetic properties of $EuZn_2P_2$ have shown that hydrostatic pressure strongly affects both magnetic (increase of the Néel temperature) and electronic (suppression of the band gap and semimetallic behavior) properties, indicating a strong interplay of structure with magnetic and electronic degrees of freedom. In this paper we deal mainly with the lattice evolution as a lattice background of the observed pressure-induced changes in the magnetic behavior for $EuZn_2P_2$ and its $EuZn_2As_2$ analogue.

The recent measured pressure dependence of the structural properties (lattice parameters) signify anisotropic evolution of the particular lattice constants signifying *a*-*a* plane to be less compressible than the *c*-parameter. Compared to another Zintl phase UCu_2P_2 it represents rather opposite trend. This experimentally confirmed fact stays behind the anisotropy in magnetic interactions and major type of magnetic order of the particular compound.

$EuZn_2As_2$ represents As-based counterpart of $EuZn_2P_2$ with larger unit-cell volume. By the pressure application, we are thus able to cover the whole range to continuously follow physical properties of the Eu-based Zintl systems within the volume-dependence from the “ambient-$EuZn_2As_2$” down to “high-pressure $EuZn_2P_2$” structural relations. Aspects of the crystal structure including the anisotropy of $EuZn_2P_2$ and $EuZn_2As_2$ upon application of pressure are to be main subject of the presentation.

[1] D. Rybicki, et al., Phys. Rev. B, 110, 2024, 014421.

[2] S. Luo, et al., Phys. Rev. B, 108, 2023, 205140.

[3] L. Havela et al., to be published

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