Influence of transition metal on magnetic properties of intermetallics – the case of $RE_5T_2In_4$ (RE = Gd-Tm; T = Ni, Rh, Pd, Pt)

S. Baran[1]

[1] *Jagiellonian University, Faculty of Physics, Astronomy and Applied Computer Science, M. Smoluchowski Institute of Physics, prof. Stanisława Łojasiewicza 11, PL-30-348 Kraków, Poland*

The $RE_5T_2In_4$ (RE = Gd-Tm; T = Ni, Rh, Pd, Pt) intermetallics crystallize with the orthorhombic $Lu_5Ni_2In_4$-type structure (space group Pbam, No. 55). Their crystal structure parameters can be found in [1-4] for T = Ni, Rh, Pd and Pt, respectively. The structure is a layered one with layers formed by the rare earth atoms separated by the layers formed by the two remaining elements. The magnetic properties of $RE_5T_2In_4$, including magnetocaloric performance and/or magnetic structures for selected compounds, have been reported in a number of papers ([5-8] for T = Ni, Rh, Pd and Pt, respectively). In the $Lu_5Ni_2In_4$-type crystal structure, the rare earth atoms occupy three non-equivalent Wyckoff sites. Such a distribution of the magnetic atoms leads to competition of different magnetic interactions, resulting in appearance of complex magnetic properties, like: coexistence of ferro- and antiferromagnetic components of the magnetic structure, diferent propagations vectors describing magnetic order in different magnetic sublattices, temperature- and/or magnetic field-induced magnetic transitions of the order-order type, individual critical temperatures of magnetic ordering for individual magnetic sublattices. Interestingly, for a fixed T-element, the critical temperatures of magnetic ordering are significantly lower for the Rh-based compounds when compared to those of the Ni-, Pd- and Pt-related ones, indicating an important role of number of the d-electrons of the transition metal in formation of magnetic order. This feature makes possible construction of hybrid functional materials showing good magnetocaloric performance over wide temperature interval.

References:

[1] V.I. Zaremba, Ya.M. Kalychak, P.Yu. Zavalii and V.A. Bruskov, Kristallografiya 36 (1991) 1415
[2] R. Zaremba, W. Hermes, M. Eul and R. Pöttgen, Z. Naturforsch. 63b (2008) 1447
[3] L. Sojka, M. Dashkevych, B. Belan, M. Manyako, V. Davydov, L. Akselrud and Ya.M. Kalychak, Ukr. Chem. J. 74 (2008) 90
[4] R. Zaremba, U.Ch. Rodewald and R. Pöttgen, Monatshefte fur Chemie 138 (2007) 819
[5] Z. Zhang, X. Dong, Q. Wang and L. Li, Intermetallics 100 (2018) 136, and references therein
[6] A.R. Hayyu, S. Baran, A. Deptuch and A. Szytuła, arXiv:2505.14831 [cond-mat.mtrl-sci]
[7] A.R. Hayyu, S. Baran and A. Szytuła, Physica B: Condensed Matter 710 (2025) 417184, and references therein
[8] A.R. Hayyu, S. Baran, A. Szytuła, K. Berent and A. Deptuch, Journal of Alloys and Compounds 1001 (2024) 175054, and references therein

This research was supported by the Excellence Initiative - Research University Program at the Jagiellonian University in Kraków.