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Reviewer report

for the Habilitation thesis **"Pressure impact on physical behavior of intermetallics"**
by Dr. Jiři Prchal.

Intermetallic compounds (IC) are a class of materials playing an important role in our daily life and in the modern industry. Among their most outstanding physical behaviors are permanent magnetism, superconductivity, thermoelectricity, shape memory effects, spectacular mechanical properties (e.g. hardness, elasticity, chemical and thermal stability, etc.). Besides these well-established phenomena IC are also known to reveal numerous exotic states as e.g. topological, quantum critical, heavy fermion, non-Fermi liquid etc. These attract attention of scientists especially in the view of the current progress in the theoretical physics, especially in the field of quantum mechanical calculations (i.e. Density Functional Theory). Knowing a band structure of a certain IC one could not only predict its possible properties, but also attempt their improvement. Such a tuning has always been a decisive factor in new materials development. As it is shown in the past few decades, mechanical and chemical pressures are of the highest priority among the tunable parameters. In his habilitation thesis Dr. Prchal reports on the impact of pressure on crystal structures, magnetic, electrical transport and thermodynamic properties of some important classes of IC (i.e. 1:1:1, 1:2:2, Laves phases etc.).

To perform the high pressure measurements Dr. Prchal and his team have chosen a new medium. Daphne Oil 7575 was found to possess higher solidification pressure and thus, to be more suitable for the planned experiments. Further, the series of the well-known *RT*Al compounds crystallizing with the hexagonal ZrNiAl type was targeted. A combined experimental and theoretical study allowed to get deeper insight in the understanding of the first order structural phase transition occurring there at lower temperatures. Then, the influence of hydrostatic pressure on the transition as well as on the magnetic properties of *RT*Al was studied. Further interesting topic, to which Dr. Prchal paid attention in his work were compounds crystallizing with $ThCr_2Si_2$ type. In the past decade

famous Fe_2As_2-series of high temperature superconductors revealing the same structural arrangement was discovered thus, raising the interest to this materials class. The temperature-pressure phase diagrams constructed by author for $EuRu_2P_2$ and $CePd_2Al_2$ are an interesting contribution to the solid state physics and allow to understand better the nature of the observed transitions. Also, beyond any doubt, the obtained results on parimagnetism in Co-containing Laves phases as well as on the U-containing intermetallics will attract attention of the broader community of solid state chemists and physicists. As it is known, the understanding of the localization of 5*f* electrons is still poor and with this respect new experimental results on this topic are strongly required.

The habilitation thesis of Dr. Prchal is nicely written and well organized. The only thing I was missing therein is an appropriate structural discussion with some pictures of crystal structures and their relationships. Such a lack is especially pronounced in the first section of the work entitled „Structural changes…". Also, I would not agree with the statement that an effective magnetic moment of 0.1 μ_B obtained for $YbAu_2Si_2$ and originating obviously from the Yb_2O_3 impurity could indicate this silicide "to be close to any magnetic instability" (p. 12).

To perform all mentioned above characterizations, handlings, measurements and preparations Dr. Prchal should master a large diversity of different methodologies including syntheses of bulk samples and crystal growth, different diffraction techniques and measurements of numerous physical properties. All these would not become possible without being enthusiastic about his job and permanently having new ideas.

I am convinced that the habilitation thesis of Dr. Prchal is an original work and has nothing in common with plagiarism, despite the high percentage of coincidence in the originality check done by *Turnitin* system. Obviously, this can be explained by the fact that the reviewed thesis is a collection of reprints of several published papers co-authored by Dr. Prchal. Here I would like to stress, that Dr. Prchal is co-authoring 79 scientific publications in such internationally recognized journals as e.g. Physical Review B (11), Journal Alloys and Compounds (11), Journal of Magnetism and Magnetic Materials (8), Journal of Physics Condensed Matter (7), etc. They were published within 2004-2021 and are cited 351 times. His current *h*-index in *scopus* is 10. Also, Dr. Prchal is permanently supervising scientific works of students. Since 2008, seven BSc, five MSc and two PhD theses were successfully performed under his supervision. All these clearly indicates that Dr. Prchal is an independent researcher recognized on the international level and possesses great teaching experiences and abilities. Taking into account these facts, I have to conclude that **the Dr. Habil. degree can be awarded to the author** by the advisory board of the faculty of Mathematics and Physics of Charles University in Prague.

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