

Referee's report of the Thesis

Superconductivity and electronic properties of γ -U alloys and their hydrides.

by Ilya Tkach

The Thesis deals with electronic properties of γ -uranium phase of U-Mo and U-Zr alloys at low temperatures, mainly in temperature range 2 – 300 K. The γ -U phase was stabilized by fast quenching from their melts using the splat quenching method. The structure of the splats was characterized by X-ray powder diffraction, scanning electron microscopy, and transmission electron microscopy. Analysis of electronic properties is based on the results obtained by measurements of magnetization, heat capacity, and electrical resistivity.

The Thesis was accomplished at Charles University in Prague, Faculty of Mathematics and Physics, Department of Condensed Matter Physics, under the supervisor Doc. RNDr. Ladislav Havela, CSc.

In the introduction part of the Thesis the author very briefly summarize several topics on electronic and magnetic properties of actinides, basic ideas on superconductivity, Bardeen, Cooper, and Schrieffer theory of superconductivity, and current knowledge on uranium-based superconductors. Information on structure and properties of γ – uranium phase, hydrides and uranium hydride is also presented there.

Experimental details are given in the fifth chapter. There are described the sample preparation (alloys and splats), hydrogenation and desorption of the splats, and experimental techniques mentioned above.

The sixth chapter contents experimental results and discussion. This part of the Thesis is written in a very condensed form. Some additional dividing in subsection would be useful, e.g. on page 78, last sentence, where the new report on specific heat measurements starts just after results and discussion of magnetization measurements.

The general conclusions are given in the final chapter with some suggestion for future work. The conclusions of the Thesis are clear and they reflect the main result obtained. Its size is proportional to the content of the work.

In evaluation of the Thesis I would like to emphasis its merits:

- i/ careful analysis of the state of art of the research and published results on the materials studied
- ii/ broad spectrum of applied experimental methods
- iii/ precise analysis of the experimental data

Finally it must be mentioned that Ilya Tkach published the results in 12 + one accepted, most of them in high impacted journals.

Comments and questions.

1. Information of mean coherent volumes, which could be derived from XRPD results, may be interesting parameters of the samples.
2. Is it possible to exclude an effect of strains on peak broadening in XRPD induced by splat quenching?
3. Is it correct to discuss the values of specific resistivity when the forms and sizes of the samples were difficult to measure as well as the distances between the wires used for four probe methods are also inaccurate?
4. A measurement of the heat capacity on PPMS is carried out in high vacuum and takes long time. Is the stability of hydrides checked at 300 K in this vacuum for long time?
5. Could interparticle interactions influence results of measurements of magnetic properties on particles fixed in glue?

To sum up, I can state that Ilya Tkach has shown his research abilities in the field of exacting sample preparation, their structure characterization and measurements of magnetization, heat capacity and electrical resistivity. He showed independence in the scientific work, collaboration in a research team. His range of accomplishment is definitely very high and his work reached a high quality. The Thesis demonstrates the innovation and high degree of creative thinking and skilful performance. I recommend the Thesis for the defence.

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