Effective energies of crystallization in

$Y_{50-x}Ce_xCu_{42}Al_8$ (x = 0, 10, 15, 25) alloys

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The heavy-fermion (HF) behaviour was found not only in selected crystalline compounds, but also in amorphous or nanocrystalline Ce-based metallic alloys [1, 2]. The structural disorder, lattice defects or granular structure can strongly enhance this effect. This influence can be successfully studied as a function of the number and size of nanocrystalline grains embedded in an amorphous matrix. In this work the HF properties of $Y_{50-x}Ce_xCu_{42}Al_8$ series alloys will be studied. These compositions have been chosen because of their significant glass forming ability necessary to prepare fully amorphous ribbon [3] and because of Ce properties (variable electronic structure, unstable valence states) which are preconditions of strongly correlated electron phenomena [4]. The first part of these studies is to prepare the samples with desired structural parameters, the next step is to examine their magnetic properties (in progress).

The amorphous ribbons of $Y_{50-x}Ce_xCu_{42}Al_8$ (x = 0, 10, 15, 25) were produced by arc-melting followed by one-wheel melt-spinning in protective atmosphere of Ar. The ribbons obtained were studied with differential scanning calorimetry (DSC) with heating rates from 10 to 50 K/min, to specify the characteristic crystallization parameters. Afterwards, the samples were annealed at different conditions determined from the DSC curves. Upon the heat treatment the nanocrystalline phases arises in the amorphous matrix. Crystalline volume fraction and mean grain size of these crystalline phases were calculated on the basis of x-ray diffraction patterns. There are two main peaks (stages) of crystallization. With increasing content x, the crystallization onset and peak temperatures move to lower values, and the second peak grows. There is a glass transition with ΔT_g of about 26 K, observed in samples with x>10. There are two main phases in the alloys examined: YCu (*Pm-3m* space group) and YCuAl (*P62m*), with partial substitution of Y by Ce in alloys with higher Ce content. Characteristic temperatures and enthalpies of crystallization process were determined with the apparatus dedicated software. Effective activation energies were calculated from the Kissinger relation [5] to be 569, 343, 364 and 247 kJ/mol for x = 0, 10, 15 and 25, respectively.

[1] S.-W. Han, C.H. Booth, E.D. Bauer, P.H. Huang, Y.Y.Chen, J.M. Lawrence, Phys. Rev. Lett. 97 (2006) 097204
[2] Y.Y. Chen, Y.D. Yao, C.R. Wang, W.H. Li, C.L. Chang, T.K. Lee, T.M. Hong, J.C. Ho, S.F. Pan, Phys. Rev. Lett. 84 (2000) 4990
[3] B. Zhang, R.J. Wang, D.Q. Zhao, M.X. Pan, W.H. Wang, Phys. Rev. B 70 (2004) 224208
[4] E. Bauer, Adv. Phys. 40 (1991) 417
[5] H.E. Kissinger, Anal. Chem. 29 (1957) 1702