MM 51: Liquid and Amorphous Metals III - Electronic properties of amorphous alloys

Time: Thursday 10:15–11:15 Location: IFW A

MM 51.1 Thu 10:15 IFW A

How structures form and properties emerge — •Peter Häussler — Chemnitz University of Technology, Physics Institute, 09107 Chemnitz, Germany

The formation of crystals and the accompanied emergence of their physical properties are far from being understood. Quantum chemistry, statistical physics, as well as thermodynamics all play an indispensable role. But, each of them is unable to solve the problem alone. The formation of structure cannot be explained by interacting individual atoms alone, instead, their cooperative actions should properly be accounted too. Cooperatively acting species would reduce the tremendous number of parameters to a manageable level. In this contribution we report on global subsystems and their interaction. Under the given external constraints they form global resonances by self-organizing mutually their internal features, causing global antibonding as well as bonding states at different energies. Accordingly, by occupying the latter, both, the decrease of the total energy and the creation of entropy become maximal. Pseudo-gaps arise at the Fermi energy and by this, major structural features are influenced. Electronic transport anomalies, the thermal stability, as well as many others emerging physical quantities are strongly influenced.

Our description follows the formal language of thermodynamics by an extended version (General Dynamics) applied to the global subsystems and introduces momentum as well as angular momentum, both included in quantum chemistry and statistical physics, but not in classical thermodynamics, so is able to form a bridge between them.

MM 51.2 Thu 10:30 IFW A

What do electron energy loss spectra of binary amorphous Al-TM alloys tell us? — •Martin Stiehler, Syed Sajid Ali Gillani, Pierre Pudwell, Hans Weber, and Peter Häussler — Technische Universität Chemnitz, D-09107 Chemnitz

Some time ago (J. Phys. Chem. Sol. **68** (2007) 1244) we reported on an intriguing systematic feature in the electron energy loss spectra of binary *amorphous* (*a*) Al alloys with transition metals (TM) from the fourth period of the periodic table (3d-TM). If interpreted as caused by the excitation of volume plasmons the 3d-TM would have to be counted with a constant valency of 5 e/a irrespective of the particular 3d-TM and irrespective of their concentration in the alloy. In contrary to amorphous alloys without d-states at the Fermi edge this valency would not coincide with the “usual” valency used in calculating, for example, the Fermi-sphere diameter.

In our talk data on *a*-Al-(Ca,Sc,Ti,V,Cr,Mn,Fe,Co,Ni,Y,Pd,Ce) is presented, showing that the aforementioned systematics can also be observed in systems with 4d- and 5d-TM. One possible explanation is based on the influence of inter-/intraband transitions due to the d-states of the TM. For further insight we compare our results with literature data on systems with non-transition metals like Al-(Mg,Zn) in the *crystalline* state and with *amorphous* Ga-Mn alloys. The latter is to clarify the role of Al in the systems.

MM 51.3 Thu 10:45 IFW A

Amorphous Al-Pd Alloys – Structure and electronic properties — •Pierre Pudwell, Martin Stiehler, and Peter Häussler — Technische Universität Chemnitz, 09107 Chemnitz

The electronic influence on the formation of the static structure in condensed matter is known since decades. Furthermore, it is also known that not only the latter *subsystem* is able to adjust, but the *electronic subsystem* itself is also variable. Amorphous alloys were found to be perfectly suited to explore this *mutual* relationship which is based on an internal exchange of momentum between the two mentioned subsystems, in detail. Both subsystems try to come into *resonance* to each other. During the last years we reported on a particular variability of the electronic subsystem in Al-3d-TM alloys (TM: Sc, . . . , Cu) by *hybridization effects* between Al-3p- and TM-3d-states. In order to test whether such a *hybridization-enhanced resonance* is also effective in other systems, we are about to extend our investigations to systems with 4d- and 5d-TM.

In our contribution we show data on Al-Pd alloys as representative for a system with 4d-TM. Thin films of the material with thicknesses around 50 nm were deposited in high-vacuum at cryogenic temperatures. The electrical resistivity was measured during annealing to several hundred K, the static atomic structure after annealing to 350K. By comparing the diameter of the strongest diffraction ring with the diameter of the Fermi-sphere, stabilizing resonances based upon different mechanisms, leading to several concentration regions with different structural and electronic behaviour, were identified.

MM 51.4 Thu 11:00 IFW A

Magnetic-Nonmagnetic Transition Observed by Disorder-Order Transition in Quasicrystalline AlPdFe Thin Films by means of Magnetotransport Properties — •Jose Barzola-Quiquia[1,2], Martin Stiehle[2], and Peter Häussler[2] — [1]Abteilung Supraleitung und Magnetismus, Institut für Experimentelle Physik II, Universität Leipzig, Linnestr. 5, D-04103, Germany — [2]Abteilung Physik Dünner Schichte, Institut für Physik, Technische Universität Chemnitz, D-09107, Germany

We report measurement results of the electrical resistivity, magnetoresistance and Hall effect of $Al_{70}Pd_{20}Fe_{10}$ alloy in amorphous and quasicrystalline phases. The measurements were performed in a temperature range of 1.2 to 300 K, applying fields of ± 8 T. An anomalous contribution to the Hall effect, induced by the magnetic order is observed only in the amorphous phase, after the transformation to the ordered quasicrystalline phase, this anomalous contribution disappears. Atomic structure information obtained by transmission electron spectroscopy reveals that the local icosahedral order is already present in the amorphous phase and is improved by the transition to the quasicrystalline phase. SQUID magnetometry measurements verify the magnetic properties of the amorphous phase and confirm the parameters obtained from the resistance measurements. The experimental results can be understood in the frame of electronic stabilized systems, where hybridization effects of $Al_{-}s, p$ with $Fe_{-}d$ electrons, play an important role.