Oral presentation

Bad metal behaviour and how to control it

C. Hoch[1], T. Hohl[1], D. Kraut[1]

[1]*Ludwig-Maximilians-Universität München, Department Chemie, Butenandtstraße 5-13 (D), D-81377 Germany*

c.hoch@lmu.de

Bad metal behaviour [1,2] describes the unusual nonlinear dependency of a high specific resistivity of a metallic material with temperature. This feature is important e. g. for the decoupling of thermal and electrical conductivity, a key point for high-efficiency thermoelectrics. Also, giant magnetoresistance is coupled with bad metal behaviour. Despite the high interest in bad metals, concepts how to control this behaviour are still scarce. The physical background is well understood: bad metal behaviour is the consequence of a low concentration of conduction electrons with a very short mean free path [3]. It is, however, unclear how to translate these parameters in chemical or structural parameters which can directly be influenced by material scientists.

Over the years, we have been able to show that amalgams of the less noble metals (alkali, alkaline earth and rare earth metals) are ideal model systems to study the influence of crucial parameters on the bad metal behaviour [4-6]. The combination of an electropositive metal with mercury is beneficial here: the electronegativity difference is high, so an electron transfer takes place from the electropositive metal towards mercury. But as mercury has an extremely low electron affinity, anion formation is hindered. The consequence is a metallic amalgam with high Coulombic bonding contributions. Besides this Coulombic polarity (which reduces considerably the electron concentration), structural complexity and disorder phenomena are responsible for controlling the mean free path length. The identification of these three parameters, polarity, complexity and disorder, can be transferred onto other, technically important intermetallic systems in order to improve thermoelectric properties.

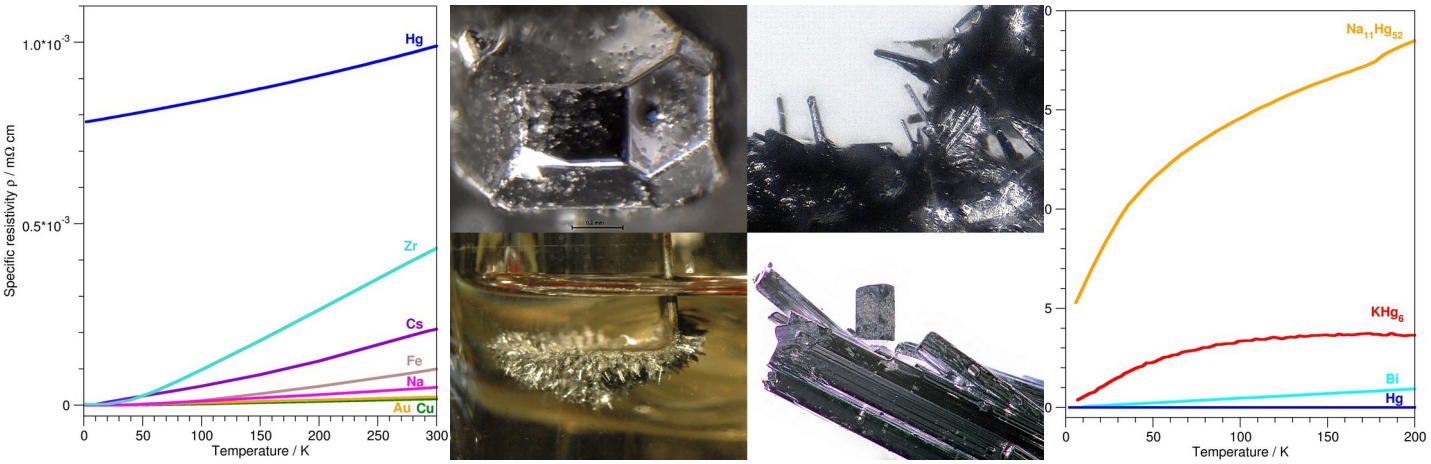

Figure 1. Left: temperature dependence of the specific resistivity of common metals; right: same for some amalgams with pronounced bad metal behaviour. Center: Amalgam crystals ($BaHg_{11}$, $Rb_xCs_{1-x}Hg_{11}$. $(N(CH_3)_4)Hg_8$, $Na_{11}Hg_{52}$, from top left to bottom right).

Amalgams of the less noble metals are accessible by different synthetic routes: electrocrystallisation [7] at low temperatures is very convenient in order to prepare the mostly temperature-sensitive Hg-richest compounds in a binary system *A*-Hg, but also conventional thermochemistry or other techniques can be utilized. Structure elucidation on single crystals or powders are impeded by the very high absorption coefficients, affording special attention with regard to absorption correction of the data sets.

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