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## Element 114 chemistry and what is next?

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Based on the order in periodic table, element 114 should be placed in the group 14, which includes such elements like C, Si, Ge, and Pb. It can be expected by the law of periodicity that E114 will reveal a more metallic behaviour than its lighter homologues. However, relativistic quantum chemical calculations predict different chemical behaviour, namely, higher inertness in comparison with lead [1-3]. In the present research an experimental determination of deposition temperature of element E114 on gold is presented.

During the present research in the irradiation of  $^{242}\text{Pu}$  with  $^{48}\text{Ca}$  (details see [4]) a decay chain was observed, which was assigned to the primary product of the nuclear fusion reaction –the isotope  $^{287}\text{E114}$  ( $T_{1/2}=0.5$  s). A deposition temperature for this isotope of  $-88$  °C was observed. This unusual first chemical observation of element E114 was confirmed switching to the projectile target combination  $^{48}\text{Ca}$  and  $^{244}\text{Pu}$ . The production of  $^{288}\text{E114}$  and  $^{289}\text{E114}$  are reported in the nuclear reactions  $^{244}\text{Pu} (^{48}\text{Ca}, 4n)$  and  $^{244}\text{Pu} (^{48}\text{Ca}, 3n)$ , respectively [5]. During this experiments two more decay chains, which were attributed to the isotope  $^{288}\text{E114}$  were observed, fully confirming the first observation. A kinetic Monte-Carlo based model of gas adsorption chromatography [6] assesses the adsorption enthalpy ( $-\Delta H_{\text{ads}}(\text{Au})$ ) from the observed deposition pattern of element 114 on the gold surface in the COLD at the applied experimental conditions as  $-\Delta H_{\text{ads}}(\text{Au})(\text{E114}) = 34 \pm 54(11)$  kJ/mol (95% c.i.). Recent relativistic density functional calculations predict the formation of a metallic bond between element 114 and gold [3]. A semi-empirical macroscopic metal-metal adsorption model [7,8] predicts adsorption enthalpy of a metal-like element 114 on gold of  $-\Delta H_{\text{ads}}(\text{Au})(\text{E114}) = 183$  kJ/mol. The adsorption enthalpy of a noble-gas like element 114 on gold surfaces was estimated to  $-\Delta H_{\text{ads}}(\text{Au})(\text{E114}) = 42 \pm 5$  kJ/mol [9]. The comparison between these theoretical values and our experimental result concludes the formation of a noble-gas like weak physisorption bond between atomic 114 and a gold surface in contrast to the expectations from the relativistic models and from empirical predictions. On a 95% confidence level element 114 is interacting weaker with gold compared to mercury. New possible experimental techniques pointed to investigation of chemical properties of super heavy elements will be discussed.

- [1] Eichler, B. Kernenergie 19, 307-311 (1976) (in German).
- [2] Seth M. et al. Angew. Chem. Int. Ed. 37, 2493-2496 (1998).
- [3] Pershina, V. et al. J. Chem. Phys. in press, (2007).
- [4] Eichler, R. et al. Angew.Chem. Int. Ed., 47, 3262-3266 (2007).
- [5] Oganessian, Yu. Ts. et al. Phys. Rev.C 70, 064609 (2004).
- [6] Zvara I. Radiochim. Acta 38, 95-101 (1985).
- [7] Eichler, B. et al. Radiochim. Acta 33, 121-125 (1983).
- [8] Eichler, B. Metal chemistry of transactinides. PSI Report 00-09, Villigen (2000), Volatilization properties of transactinides from metal surfaces and melts (thermochemical calculation). In PSI Report 03-01, Villigen (2002), ISSN 1019-0643.
- [9] Eichler, R. et al. J. Phys.Chem. B 106, 5413-5420 (2002).

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