ELECTRONIC WORK FUNCTION OF HYDROGEN-SORBING INTERMETALLIDES IN CERIUM–COBALT SYSTEM

Malov Yu.I., Fokin V.N., Fokina E.E., Tarasov B.P.*, Shilkin S.P.
Institute of Problems of Chemical Physics of Russian Academy of Sciences,
Prospect of the Academician Semenov, 1, Chernogolovka, Moscow Region,
Russian Federation, 142432.
* *Fax: 7(096)5155420 E-mail: btarasov@icp.ac.ru*

Introduction

The major characteristic of emissive properties of metal phases is the electronic work function (EWF) [1], the knowledge of EWF size is necessary at the decision of a number of theoretical and applied tasks of modern material science.

If the EWF sizes of the majority of individual metals are full enough investigated, for metal alloys, especially for the intermetallic compounds containing rare-earth and alkaline elements, the process of accumulation of experimental data, their ordering and creation of databases are only at an initial stage.

Recently the EWF measurements are considered as one of methods of the physico-chemical analysis of metal alloys.

The intermetallic compounds formed by rare-earth, alkaline and 3d-transitive metals have unique physico-chemical properties (high capacity on hydrogen, high magnetic characteristics, emissive activity etc.), which favourably distinguish them from other alloys.

In the present work the character of change of concentration dependence of EWF in binary system Ce-Co was investigated by the method of a contact difference of potentials (CDP).

Results and discussion

The CDP method is most universal of all methods of EWF definition of metal phases of various composition and structure. For the realisation this method does not require an influence of thermal, electromagnetic or other fields on a researched sample and gives the integrated characteristic of emissive properties of a surface of a solid phase in vacuum or in controllable gas environment [2]. At this method EWF is defined as a difference between EWF of a standard sample (vibrating electrode) and EWF measured by CDP method between standard and researched samples.

In the given work the EWF definition was carried out in an atmosphere of especially pure argon at 293 K on samples as the pressed tablets. The installation for measurements is described in work [3]. The error of measurements did not exceed ±0.05 eV.

The initial alloys were prepared by electroarc smelting charge from cerium (99.9 mass. % of Ce) and cobalt (99.99 mass. % of Co). Annealing carried out in the evacuated sealed quartz ampoule at 870 K within two weeks with subsequent hardening in ice water. The parameters of crystal lattices of the received alloys well will be coordinated to the literary data [4, 5].

The table contains the crystallochemical data and experimental and calculated values of EWF for six intermetallic compounds forming in rich by cobalt area of the state diagram of binary system Ce-Co.

The account of magnitudes of EWF was carried out under the formula [6]:

$$d_{AB_i} = \begin{cases} d_{A_k}\varphi_A / \varphi_{AB} \\ d_{B_j}\varphi_B / \varphi_{AB} \end{cases},$$

where d_{AB_i}, d_{A_k}, d_{B_j} – elements of Debay series of researched intermetallide AB and two initial metals A and B (Å); φ_A, φ_B, φ_{AB} – accordingly the electronic work function of metals A, B and intermetallide AB in a polycrystalline state (eV).

Thus the arrangement of all reflexes, found out in the appropriate range on the diffractograms of intermetallides and initial metals, was taken into account.

As it is visible from the submitted data, the experimental and accounted magnitudes of EWF will not bad be coordinated among themselves. The minimal magnitudes of EWF within the limits of a mistake of definition are observed at the intermetallic compounds $CeCo_3$ and $CeCo_5$. As follows from works [4, 5], the character of interaction of the compounds in Ce-Co system with hydrogen differs essentially and does not contradict the received magnitudes of EWF. The minimal magnitudes of EWF correspond to the steadiest compounds in Ce-Co system.

Conclusions

The electronic work function of the intermetallic compounds existing in rich by cobalt field of the state diagram of Ce-Co system was determined by the method of a contact difference of potentials. The minimal magnitudes of EWF answer the steadiest in relation to action of hydrogen compounds in system Ce-Co.

Table. The crystallochemical data, experimental and calculated values of EWF for intermetallic compounds formed in Ce-Co system.

No.	Intermetallide	$\varphi_{exp.}$, eV	$\varphi_{cal.}$, eV	Syngony	Parameters of a lattice, Å	
					a	*c*
1	$CeCo_2$	4.16	4.12	cubic	7.160±0.005	–
2	$CeCo_3$	3.77	4.10	rhombohedral	4.958±0.004	24.785±0.008
3	Ce_2Co_7	4.16	4.16	hexahedral	4.946±0.004	24.490±0.005
4	Ce_5Co_{19}	4.17	4.20	rhombohedral	4.940±0.005	4.875±0.005
5	$CeCo_5$	4.15	4.18	hexahedral	4.928±0.005	4.014±0.008
6	Ce_2Co_{17}	4.16	4.18	hexahedral	8.371±0.007	8.125±0.007

References

1. Physical values: Reference book / Babichev A.P., Babushkina O.N., Bratkovsky A.M. et al. // Edited by Grigor'ev I.S., Meilikhov E.Z. M.: Energo-atomizdat, 1991. 1232 p. (in Russian).
2. Savitsky E.M., Burov I.V., Litvak L.N. Dok. Acad. Nauk SSSR, 1974;218(4): 818-820 (in Russian).
3. Onishchenko A.V., Malov Yu.I., Korol'kov V.A. Metrologiya, 1979;(5):49-53 (in Russian).
4. Semenenko K.N., Burnasheva V.V., Fokin V.N., Fokina E.E., Troitskaya S.L. Zh. Obshchei Khimii, 1982;.53(7):.1443-1447 (in Russian).
5. Fokin V.N., Burnasheva V.V, Fokina E.E, Troitskaya S.L., Semenenko K.N. Neorgan. Mater., 1982;18(11): 1909 (in Russian).
6. Onishchenko A.V. Zh. Phiz. Khimii, 1982; 56(1): 158-161 (in Russian).