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STUDY OF SUPERCONDUCTING EFFECTS IN TRANSITION METALS BASED BINARY ALLOYS USING PSEUDOPOTENTIAL THEORY

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Superconducting state parameters (SSP) (viz., electron-phonon coupling strength λ, Coulomb pseudopotential μ^*, transition temperature T_C, isotope effect exponent α and effective interaction strength $N_O V$) of transition metals based binary alloys are studied using − for the first time − a potential formalism with a pseudo-atom-alloy model. In the study, noticeable influence of various exchange and correlation functions on λ and μ^* has been revealed. The SSP results are found to be in a qualitative agreement with the available experimental data.

1. INTRODUCTION

During last several years, the superconductivity remains a dynamic area of research in the condensed matter physics, with continual discoveries of novel materials and an increasing demand for novel devices in sophisticated technological applications. A large number of metals and amorphous alloys are superconductors, with the critical transition temperature T_C ranging from 1 to 18 K. Even some heavily doped semiconductors have also been found to be superconductors. To explain the superconducting state parameters (SSP) of metallic complexes the pseudopotential theory is successfully used [1–10]. In these works, a well-known *pseudopotential model* is employed for the SSP calculation of metallic complexes. Studying the SSP of binary-alloy-based superconductors may be of great help for many applications; in turn, studying the dependence of transition temperature on the composition of metallic elements is helpful in finding new superconductors with high T_C. Recently, we have studied the SSP of some binary complexes using the single parametric model formalism [3–8]. The application of pseudopotential to binary alloys involves the assumption of pseudoions with averaged properties, which are assumed to replace three types of ions in the binary systems, while gas of free electrons is assumed to permeate through them. The electron-pseudoion is accounted for by the pseudopotential, and the electron–electron interaction is involved through a dielectric screening function. For successful prediction of the superconducting properties of alloy systems, proper selection of the pseudopotential and screening function is essential [3–8].

In the present work, a well-known empty core (EC) model potential of Ashcroft [11] is applied to study SSP (namely, electron-phonon coupling strength

λ, Coulomb pseudopotential μ^*, transition temperature T_C, isotope effect exponent α and effective interaction strength $N_O V$ of transition metals based binary alloys (TMBBAs). To see the impact of various exchange and correlation functions on the aforesaid properties, we have used five different types of local field correction functions proposed by Hartree [12], Taylor [13], Ichimaru–Utsumi [14], Farid *et al.* [15], and Sarkar *et al.* [16] (further in the text: H, T, IU, and F, respectively). We have incorporated − for the first time − the more advanced and newly developed local field correction functions: IU, F and S, in the investigation of the SSP of TMBBAs. In the present work, we report the use for this purpose of a pseudopotential method with five different types of local field correction functions.

In our work, the pseudo-alloy-atom (PAA) model was used to explain the electron–ion interaction for binaries. It is well known that this model is a more meaningful approach to elucidate such kind of interactions in binary systems [3–8]. To describe the electron-ion interactions in the binary systems, the mentioned above Ashcroft EC single parametric local model potential [11] is employed. According to Ashcroft, the form factor $W(q)$ of the EC model potential in the wave number space is (in au):

$$W(q) = \frac{-8\pi Z}{\Omega_O q^2 \varepsilon(q)} \cos(q r_C), \tag{1}$$

where $Z, \Omega_O, \varepsilon(q)$ and r_C are the valence, atomic volume, Hartree's dielectric function and the parameter of the model potential of TMBBAs, respectively. Our study is differentiated from work [11] in such a way that the model potential parameter is there mostly fitted with the experimental data for transition temperature T_C, while in the present work the model potential parameter r_C is determined using the first zero of the form factor.

2. METHOD OF COMPUTATION

In the present investigation of binary mixtures, the electron-phonon coupling strength λ is computed using the relation [1–10]:

$$\lambda = \frac{m_b \, \Omega_O}{4\pi^2 \, k_F \, M \, \langle \omega^2 \rangle} \int_0^{2k_F} q^3 \left| W(q) \right|^2 dq \, . \tag{2}$$

Here m_b – the band mass,
M – the ionic mass,
Ω_O – the atomic volume,
k_F – the Fermi wave vector, and
$W(q)$ – the screened pseudopotential.

The effective averaged square phonon frequency $\left\langle \omega^2 \right\rangle$ is calculated using the relation given by Butler [17]: $\left\langle \omega^2 \right\rangle^{1/2} = 0.69 \theta_D$, where θ_D is Debye's temperature of the TMBBAs.

Using equalities $X = q/2k_F$ and $\Omega_O = 3\pi^2 Z/(k_F)^3$, we obtain Eq. (2) in the following form:

$$\lambda = \frac{12\, m_b\, Z}{M\ \langle \omega^2 \rangle} \int_0^1 X^3 \left| W(X) \right|^2 dX \quad , \tag{3}$$

where Z and $W(X)$ are the valence and the screened EC pseudopotential [14] of the TMBBAs, respectively.

The Coulomb pseudopotential is given in [1–10] as

$$\mu^* = \frac{\dfrac{m_b}{\pi\, k_F} \int_0^1 \dfrac{dX}{\varepsilon(X)}}{1 + \dfrac{m_b}{\pi\, k_F} \ln\left(\dfrac{E_F}{10\, \theta_D} \right) \int_0^1 \dfrac{dX}{\varepsilon(X)}} \quad , \tag{4}$$

where E_F – the Fermi energy,

m_b – the band mass of the electron, and

$\varepsilon(X)$ – a modified Hartree dielectric function, which is written as [12]

$$\varepsilon(X) = 1 + (\varepsilon_H(X) - 1)(1 - f(X)). \tag{5}$$

Here $\varepsilon_H(X)$ is the static Hartree dielectric function [12], and $f(X)$ is the local field correction function. In the present investigation, the local field correction functions due to H, T, IU, F and S are incorporated to see the impact of exchange and correlation effects. The details of all the local field correction functions are found from their respective papers [12–16].

After evaluating λ and μ^*, the transition temperature T_C and the isotope effect exponent α are investigated from the McMillan formulas [1–10]:

$$T_C = \frac{\theta_D}{1.45} \exp\left[\frac{-1.04(1+\lambda)}{\lambda - \mu^*(1+0.62\lambda)} \right], \tag{6}$$

$$\alpha = \frac{1}{2}\left[1 - \left(\mu^* \ln \frac{\theta_D}{1.45 T_C} \right)^2 \frac{1+0.62\lambda}{1.04(1+\lambda)} \right].$$

The effective interaction strength $N_O V$ is studied using the expression [1–10]:

$$N_O V = \frac{\lambda - \mu^*}{1 + \dfrac{10}{11}\lambda}. \tag{7}$$

3. RESULTS AND DISCUSSION

The input parameters of TMBBAs are computed using the metallic data of the pure components (PAA model, taken from [3–8]). In Appendix, in tabulated

form the presently calculated SSP values are given: the electron-phonon coupling strength λ, Coulomb pseudopotential μ^*, transition temperature T_C, isotope effect exponent α and effective interaction strength $N_O V$, at various concentrations for TMBBAs taken from available experimental findings [10, 18, 19]. It is also observed that for TMBBAs the theoretical λ value goes on increasing or decreasing as the concentration of another metallic component changes. The increase or decrease in λ with concentration shows a gradual transition from the weak coupling behaviour of electrons and phonons to an intermediate one, which may be attributed to an increase in the hybridization of sp-d electrons of 3d, 4d or 5d-metallic elements with increasing concentration. This may also be attributed to the increased role of ionic vibrations in the 3d, 4d or 5d metal-rich region. The present results are found to be in a qualitative agreement with the mentioned experimental data ([10, 18, 19]). From the present study it follows that the percentile influence of various local field correction functions with respect to the static H-screening function on the electron-phonon coupling strength λ is 6.80%−46.75%, while that from works [10, 18, 19] is 0.00%−74.54% for TMBBAs.

The computed values of the pseudopotential μ^* accounting for Coulomb's interaction between the conduction electrons and obtained using various forms of the local field correction functions are also shown in Appendix. It is seen there that for TMBBAs the μ^* value is 0.11–0.14, which is in accordance with McMillan [10], who suggested $\mu^* \approx 0.13$ for transition metals. The weak screening influence shows on the computed values of μ^*. Similar to above, percentile influence of various local field correction functions with respect to the static H-screening function on μ^* for the TMBBAs is 2.34%−8.16%.

According to the PAA model, the input parameters are used in the computations of the electron-phonon coupling strength λ and the Coulomb pseudopotential μ^*, and, afterwards, of transition temperature T_C. Further in Appendix, T_C values are presented for TMBBAs computed from various forms of the local field correction functions along with experimental findings [10, 18, 19]. These results obtained from H-local field correction functions are also found to fit these experimental data. The calculated results of transition temperature T_C for TMBBAs deviate in the range of 0.01%−1500.63% (see [10, 18, 19].

Next, in Appendix the values of isotope effect exponent α for TMBBAs are given. The computed α values show a weak dependence on the dielectric screenings. Since the experimental value of α has not been reported in the literature so far, the present relevant α data may be used for studying ionic vibrations in the superconductivity of alloying substances. The negative α value is observed for $V_{0.40}Cr_{0.60}$, $V_{0.20}Cr_{0.80}$, $V_{0.10}Cr_{0.90}$, $V_{0.055}Cr_{0.945}$, $Nb_{0.30}Mo_{0.70}$, $Nb_{0.10}Mo_{0.90}$ and $Ta_{0.10}W_{0.90}$ alloys, which indicates that the electron-phonon coupling in these metallic complexes does not fully explain all the features regarding their superconducting behaviour. The reason behind the negative values

of the isotope effect exponent α in the present computation may be due to the increased magnetic interactions of atoms. Also, the electron-lattice interactions are not deeply involved in the binary alloy superconductors, which may have caused negative values of α.

The values of the effective interaction strength $N_O V$ are listed in Appendix for different local field correction functions. These values show that the TMBBAs under investigation lie in the range of weak coupling superconductors, and that there is a feeble dependence on dielectric screenings.

Studying the data given in Appendix, one can see that among the five screening functions that due to H (only static – i.e. without exchange and correlation) gives the minimum value of the SSP, while the screening function due to F gives the maximum value. The present findings indicate that the local field correction functions due to T, IU and S are lying between these two screening functions. The local field correction functions due to IU, F and S are able to generate consistent results regarding the SSP of transition metals based binary alloys as those obtained for more commonly employed H- and T-functions.

4. CONCLUSIONS

The comparison of presently computed results with available experimental findings is highly encouraging for studying the transition metals binary alloys, confirming the applicability of the model potential. The theoretically observed values of SSP are not available for most of the TMBBAs, therefore it is difficult to draw any special remarks. However, the comparison with other theoretical data of the kind supports the present SSP computations. Such study on the SSP of other binary and multi-component alloys as well as metallic glasses is in progress.

APPENDIX

Superconducting state parameters of the transition metals based binary alloys.

Alloys	SSP	Present results					Expt. [10, 18, 19]
		H	T	IU	F	S	
1	2	3	4	5	6	7	8
$Ti_{0.80}V_{0.20}$	λ	0.53	0.71	0.74	0.74	0.63	0.54
	μ^*	0.13	0.14	0.14	0.14	0.13	–
	T_C (K)	3.50	8.82	9.83	9.90	6.33	3.5
	α	0.37	0.41	0.42	0.42	0.40	–
	$N_O V$	0.27	0.35	0.36	0.36	0.32	–
$Ti_{0.70}V_{0.30}$	λ	0.61	0.82	0.86	0.86	0.73	0.62
	μ^*	0.12	0.13	0.13	0.14	0.13	–
	T_C (K)	6.14	12.79	13.96	14.04	9.71	6.14
	α	0.41	0.43	0.44	0.44	0.43	–
	$N_O V$	0.31	0.39	0.41	0.41	0.36	–

Continue

1	2	3	4	5	6	7	8
$Ti_{0.50}V_{0.50}$	λ	0.65	0.86	0.89	0.89	0.76	0.65
	μ^*	0.12	0.13	0.13	0.13	0.13	–
	T_C (K)	7.31	13.78	14.86	14.91	10.90	7.30
	α	0.42	0.44	0.44	0.44	0.44	–
	N_OV	0.33	0.41	0.42	0.42	0.38	–
$Ti_{0.25}V_{0.75}$	λ	0.65	0.84	0.86	0.87	0.76	0.65
	μ^*	0.12	0.13	0.13	0.13	0.12	–
	T_C (K)	7.16	12.69	13.54	13.56	10.39	7.16
	α	0.43	0.44	0.45	0.45	0.44	–
	N_OV	0.33	0.40	0.41	0.41	0.38	–
$Ti_{0.15}V_{0.85}$	λ	0.65	0.82	0.85	0.85	0.75	0.65
	μ^*	0.12	0.13	0.13	0.13	0.12	–
	T_C (K)	7.02	12.15	12.89	12.91	10.05	7.02
	α	0.43	0.44	0.45	0.45	0.44	–
	N_OV	0.33	0.40	0.41	0.41	0.37	–
$V_{0.90}Cr_{0.10}$	λ	0.51	0.66	0.69	0.69	0.59	0.53, 0.28
	μ^*	0.12	0.12	0.13	0.13	0.12	0.20
	T_C (K)	3.21	7.41	8.18	8.22	5.21	3.21, 3.21, 2.6, 2.5
	α	0.39	0.42	0.42	0.42	0.41	–
	N_OV	0.27	0.34	0.35	0.35	0.30	–
$V_{0.80}Cr_{0.20}$	λ	0.45	0.58	0.61	0.61	0.52	0.48, 0.26
	μ^*	0.12	0.12	0.13	0.13	0.12	0.19
	T_C (K)	1.90	5.21	5.85	5.89	3.40	1.90, 1.90
	α	0.36	0.40	0.40	0.40	0.38	–
	N_OV	0.24	0.30	0.31	0.31	0.27	–
$V_{0.75}Cr_{0.25}$	λ	0.42	0.55	0.57	0.57	0.48	0.45, 0.32
	μ^*	0.12	0.13	0.13	0.13	0.12	0.19
	T_C (K)	1.36	4.23	4.81	4.85	2.60	1.36, 1.36
	α	0.33	0.38	0.39	0.39	0.36	–
	N_OV	0.22	0.28	0.29	0.29	0.25	–
$V_{0.60}Cr_{0.40}$	λ	0.35	0.45	0.46	0.46	0.40	0.38, 0.38
	μ^*	0.12	0.12	0.13	0.13	0.12	0.19
	T_C (K)	0.37	1.69	2.00	2.01	0.91	0.37, 0.37
	α	0.23	0.32	0.33	0.33	0.29	–
	N_OV	0.18	0.23	0.24	0.24	0.20	–
$V_{0.50}Cr_{0.50}$	λ	0.31	0.39	0.40	0.40	0.35	0.33, 0.43
	μ^*	0.12	0.12	0.13	0.13	0.12	018
	T_C (K)	0.10	0.69	0.84	0.85	0.32	0.10
	α	0.11	0.25	0.26	0.26	0.20	–
	N_OV	0.15	0.20	0.20	0.20	0.17	–

Continue

1	2	3	4	5	6	7	8
$V_{0.40}Cr_{0.60}$	λ	0.28	0.36	0.37	0.37	0.32	0.28, 0.46
	μ^*	0.12	0.13	0.13	0.13	0.12	0.18
	T_C (K)	0.03	0.33	0.43	0.43	0.13	<0.025, <0.015
	α	–0.03	0.17	0.19	0.19	0.10	–
	N_OV	0.13	0.17	0.18	0.18	0.15	–
$V_{0.20}Cr_{0.80}$	λ	0.20	0.25	0.26	0.26	0.23	0.20, 0.56
	μ^*	0.12	0.13	0.13	0.13	0.12	0.18
	T_C (K)	0.00	0.00	0.00	0.00	0.00	<0.015
	α	–1.58	–0.57	–0.50	–0.50	–0.85	–
	N_OV	0.07	0.10	0.11	0.11	0.09	–
$V_{0.10}Cr_{0.90}$	λ	0.20	0.25	0.26	0.26	0.22	0.20, 0.63
	μ^*	0.12	0.13	0.13	0.13	0.12	0.18
	T_C (K)	0.00	0.00	0.00	0.00	0.00	<0.015
	α	–1.58	–0.57	–0.49	–0.49	–0.86	–
	N_OV	0.07	0.10	0.11	0.11	0.09	–
$V_{0.055}Cr_{0.945}$	λ	0.20	0.25	0.26	0.26	0.22	0.20, 0.88
	μ^*	0.12	0.13	0.13	0.13	0.12	–
	T_C (K)	0.00	0.00	0.00	0.00	0.00	<0.015
	α	–1.58	–0.57	–0.49	–0.49	–0.86	–
	N_OV	0.07	0.10	0.11	0.11	0.09	–
$r_{0.50}Nb_{0.50}$	λ	0.85	1.16	1.21	1.21	1.02	0.88
	μ^*	0.12	0.13	0.13	0.13	0.12	–
	T_C (K)	9.30	14.94	15.82	15.89	12.57	9.3
	α	0.45	0.46	0.47	0.47	0.46	–
	N_OV	0.41	0.50	0.51	0.52	0.47	–
$Zr_{0.25}Nb_{0.75}$	λ	0.90	1.20	1.25	1.25	1.06	0.93
	μ^*	0.12	0.13	0.13	0.13	0.12	–
	T_C (K)	10.80	16.41	17.26	17.32	14.02	10.8
	α	0.46	0.47	0.47	0.47	0.46	–
	N_OV	0.43	0.51	0.53	0.53	0.48	–
$Nb_{0.85}Mo_{0.15}$	λ	0.66	0.85	0.87	0.88	0.77	0.70
	μ^*	0.11	0.12	0.12	0.12	0.12	–
	T_C (K)	5.85	10.00	10.61	10.63	8.31	5.85
	α	0.44	0.45	0.45	0.45	0.45	–
	N_OV	0.34	0.41	0.42	0.42	0.38	–
$Nb_{0.60}Mo_{0.40}$	λ	0.38	0.49	0.50	0.51	0.44	0.41
	μ^*	0.12	0.13	0.13	0.13	0.12	–
	T_C (K)	0.60	2.17	2.49	2.50	1.39	0.60
	α	0.28	0.35	0.35	0.35	0.33	–
	N_OV	0.20	0.25	0.26	0.26	0.23	–

Continue

1	2	3	4	5	6	7	8
$Nb_{0.40}Mo_{0.60}$	λ	0.30	0.38	0.39	0.39	0.34	0.31
	μ^*	0.12	0.13	0.13	0.13	0.12	–
	T_C (K)	0.05	0.42	0.53	0.53	0.21	0.05
	α	0.03	0.20	0.22	0.22	0.15	–
	N_OV	0.14	0.19	0.19	0.19	0.17	–
$Nb_{0.30}Mo_{0.70}$	λ	0.27	0.35	0.36	0.36	0.31	0.29
	μ^*	0.12	0.13	0.13	0.13	0.12	–
	T_C (K)	0.02	0.20	0.25	0.26	0.09	0.016
	α	–0.11	0.12	0.14	0.14	0.06	–
	N_OV	0.12	0.17	0.17	0.17	0.15	–
$Nb_{0.20}Mo_{0.80}$	λ	0.31	0.40	0.41	0.41	0.36	0.33
	μ^*	0.12	0.13	0.13	0.13	0.12	–
	T_C (K)	0.10	0.69	0.86	0.86	0.34	0.095
	α	0.09	0.24	0.25	0.25	0.19	–
	N_OV	0.15	0.20	0.20	0.20	0.18	–
$Nb_{0.10}Mo_{0.90}$	λ	0.34	0.44	0.46	0.46	0.39	0.36
	μ^*	0.12	0.13	0.13	0.13	0.12	–
	T_C (K)	0.30	1.59	1.92	1.94	0.82	0.30
	α	0.19	0.30	0.31	0.31	0.26	–
	N_OV	0.17	0.23	0.23	0.23	0.20	–
$Mo_{0.95}Re_{0.05}$	λ	0.43	0.55	0.57	0.57	0.49	0.45
	μ^*	0.12	0.13	0.13	0.13	0.12	–
	T_C (K)	1.50	4.58	5.20	5.24	2.86	1.5
	α	0.33	0.38	0.39	0.39	0.36	–
	N_OV	0.22	0.28	0.29	0.29	0.25	–
$Mo_{0.90}Re_{0.10}$	λ	0.49	0.63	0.65	0.66	0.55	0.51
	μ^*	0.12	0.13	0.13	0.13	0.12	–
	T_C (K)	2.95	7.38	8.22	8.28	4.90	2.9
	α	0.38	0.41	0.42	0.42	0.40	–
	N_OV	0.26	0.32	0.33	0.33	0.29	–
$Mo_{0.80}Re_{0.20}$	λ	0.65	0.85	0.88	0.89	0.73	0.68
	μ^*	0.12	0.12	0.13	0.13	0.12	–
	T_C (K)	8.51	15.73	16.90	17.04	11.59	8.5
	α	0.43	0.45	0.45	0.45	0.44	–
	N_OV	0.34	0.41	0.42	0.42	0.37	–
$Mo_{0.70}Re_{0.30}$	λ	0.72	0.94	0.98	0.98	0.81	0.76
	μ^*	0.12	0.12	0.12	0.12	0.12	–
	T_C (K)	10.80	18.33	19.50	19.64	14.02	10.8
	α	0.44	0.46	0.46	0.46	0.45	–
	N_OV	0.37	0.44	0.45	0.45	0.40	–

Continue

1	2	3	4	5	6	7	8
$Mo_{0.60}Re_{0.40}$	λ	0.82	1.06	1.10	1.10	0.92	0.86
	μ^*	0.11	0.12	0.12	0.12	0.12	–
	T_C (K)	12.61	19.45	20.48	20.57	15.72	12.6
	α	0.46	0.47	0.47	0.47	0.46	–
	N_OV	0.40	0.48	0.49	0.49	0.44	–
$Mo_{0.50}Re_{0.50}$	λ	0.80	1.03	1.07	1.07	0.90	0.85
	μ^*	0.11	0.12	0.12	0.12	0.11	–
	T_C (K)	11.50	17.72	18.65	18.72	14.42	11.5
	α	0.46	0.47	0.47	0.47	0.46	–
	N_OV	0.40	0.47	0.48	0.48	0.43	–
$Mo_{0.50}Tc_{0.50}$	λ	0.86	1.08	1.11	1.12	0.98	0.91
	μ^*	0.11	0.12	0.12	0.12	0.11	–
	T_C (K)	12.61	17.95	18.67	18.69	15.57	12.6
	α	0.46	0.47	0.47	0.47	0.47	–
	N_OV	0.42	0.49	0.49	0.50	0.46	–
$Zr_{0.97}Rh_{0.03}$	λ	0.58	0.81	0.85	0.86	0.71	0.59
	μ^*	0.13	0.14	0.14	0.14	0.13	–
	T_C (K)	3.10	7.57	8.41	8.48	5.62	3.1
	α	0.40	0.43	0.43	0.43	0.42	–
	N_OV	0.30	0.39	0.40	0.40	0.35	–
$Zr_{0.96}Rh_{0.04}$	λ	0.63	0.87	0.91	0.92	0.77	0.64
	μ^*	0.12	0.13	0.14	0.14	0.13	–
	T_C (K)	3.80	8.32	9.14	9.20	6.44	3.8
	α	0.41	0.44	0.44	0.44	0.43	–
	N_OV	0.32	0.41	0.43	0.43	0.38	–
$Zr_{0.95}Rh_{0.05}$	λ	0.69	0.96	1.00	1.01	0.85	0.70
	μ^*	0.12	0.13	0.13	0.13	0.13	–
	T_C (K)	4.80	9.42	10.22	10.27	7.58	4.8
	α	0.43	0.45	0.45	0.45	0.44	–
	N_OV	0.35	0.44	0.45	0.46	0.41	–
$Zr_{0.94}Rh_{0.06}$	λ	0.76	1.04	1.09	1.10	0.93	0.78
	μ^*	0.12	0.13	0.13	0.13	0.13	–
	T_C (K)	5.75	10.34	11.11	11.15	8.58	5.75
	α	0.44	0.46	0.46	0.46	0.45	–
	N_OV	0.38	0.47	0.48	0.48	0.43	–
$Zr_{0.93}Rh_{0.07}$	λ	0.78	1.06	1.12	1.12	0.95	0.80
	μ^*	0.12	0.13	0.13	0.13	0.13	–
	T_C (K)	5.95	10.49	11.24	11.29	8.76	5.95
	α	0.44	0.46	0.46	0.46	0.45	–
	N_OV	0.38	0.47	0.49	0.49	0.44	–

Continue

1	2	3	4	5	6	7	8
$Hf_{0.30}Ta_{0.70}$	λ	0.78	1.06	1.11	1.12	0.92	0.82
	μ^*	0.12	0.12	0.13	0.13	0.12	–
	T_C (K)	6.81	11.72	12.50	12.59	9.44	6.81
	α	0.45	0.46	0.46	0.46	0.46	–
	N_OV	0.39	0.48	0.49	0.49	0.44	–
$Re_{0.70}Os_{0.30}$	λ	0.44	0.56	0.58	0.58	0.49	0.47
	μ^*	0.11	0.12	0.12	0.12	0.12	–
	T_C (K)	1.45	4.11	4.63	4.67	2.56	1.45
	α	0.36	0.40	0.40	0.40	0.38	–
	N_OV	0.23	0.29	0.30	0.30	0.26	–
$Ta_{0.84}W_{0.16}$	λ	0.58	0.78	0.82	0.82	0.68	0.51
	μ^*	0.12	0.12	0.13	0.13	0.12	–
	T_C (K)	3.80	8.22	8.99	9.07	5.96	1.85, 3.8
	α	0.42	0.44	0.44	0.44	0.43	–
	N_OV	0.31	0.38	0.40	0.40	0.35	–
$Ta_{0.60}W_{0.40}$	λ	0.49	0.65	0.68	0.68	0.57	0.39
	μ^*	0.12	0.13	0.13	0.13	0.12	–
	T_C (K)	2.00	5.37	6.03	6.09	3.58	2.0
	α	0.38	0.42	0.42	0.42	0.40	–
	N_OV	0.26	0.33	0.34	0.34	0.30	–
$Ta_{0.40}W_{0.60}$	λ	0.41	0.54	0.57	0.57	0.48	0.25
	μ^*	0.12	0.13	0.13	0.13	0.12	–
	T_C (K)	0.85	3.07	3.55	3.59	1.83	0.85
	α	0.32	0.38	0.39	0.39	0.36	–
	N_OV	0.21	0.28	0.29	0.29	0.25	–
$Ta_{0.20}W_{0.80}$	λ	0.33	0.44	0.45	0.45	0.38	0.26
	μ^*	0.12	0.13	0.13	0.13	0.12	–
	T_C (K)	0.16	1.06	1.31	1.33	0.50	0.16
	α	0.17	0.30	0.31	0.31	0.26	–
	N_OV	0.16	0.22	0.23	0.23	0.19	–
$Ta_{0.10}W_{0.90}$	λ	0.27	0.35	0.36	0.36	0.31	0.27
	μ^*	0.12	0.13	0.13	0.13	0.12	–
	T_C (K)	0.01	0.20	0.27	0.27	0.07	–
	α	–0.12	0.14	0.17	0.17	0.06	–
	N_OV	0.12	0.17	0.18	0.18	0.15	–
$W_{0.95}Re_{0.05}$	λ	0.32	0.42	0.44	0.44	0.37	0.32
	μ^*	0.12	0.13	0.13	0.13	0.12	–
	T_C (K)	0.12	0.89	1.12	1.13	0.40	–
	α	0.14	0.28	0.29	0.29	0.23	–
	N_OV	0.16	0.21	0.22	0.22	0.19	–

1	2	3	4	5	6	7	8
$W_{0.925}Re_{0.075}$	λ	0.38	0.50	0.52	0.52	0.44	0.38
	μ^*	0.12	0.13	0.13	0.13	0.12	–
	T_C (K)	0.57	2.49	2.95	2.99	1.31	–
	α	0.28	0.36	0.36	0.36	0.32	–
	N_OV	0.19	0.26	0.27	0.27	0.23	–
$W_{0.90}Re_{0.10}$	λ	0.39	0.51	0.54	0.54	0.45	0.42
	μ^*	0.12	0.13	0.13	0.13	0.12	–
	T_C (K)	0.70	2.83	3.32	3.36	1.54	0.7
	α	0.29	0.37	0.37	0.37	0.34	–
	N_OV	0.20	0.27	0.27	0.28	0.23	–
$Re_{0.30}Os_{0.70}$	λ	0.42	0.56	0.59	0.59	0.48	0.42
	μ^*	0.12	0.13	0.13	0.13	0.12	–
	T_C (K)	1.14	4.16	4.81	4.91	2.21	–
	α	0.32	0.39	0.39	0.39	0.36	–
	N_OV	0.22	0.29	0.30	0.30	0.25	–
$W_{0.85}Re_{0.15}$	λ	0.48	0.63	0.66	0.66	0.55	0.50
	μ^*	0.12	0.12	0.13	0.13	0.12	–
	T_C (K)	2.26	6.18	6.94	7.03	3.87	2.26
	α	0.37	0.41	0.42	0.42	0.39	–
	N_OV	0.25	0.32	0.33	0.33	0.28	–
$W_{0.80}Re_{0.20}$	λ	0.52	0.68	0.71	0.71	0.59	0.54
	μ^*	0.12	0.12	0.13	0.13	0.12	–
	T_C (K)	3.20	7.78	8.62	8.72	5.11	3.20
	α	0.39	0.42	0.43	0.43	0.41	–
	N_OV	0.27	0.34	0.36	0.36	0.31	–
$W_{0.75}Re_{0.25}$	λ	0.57	0.75	0.78	0.79	0.65	0.60
	μ^*	0.12	0.12	0.12	0.12	0.12	–
	T_C (K)	4.64	9.97	10.89	11.01	6.89	4.64
	α	0.41	0.44	0.44	0.44	0.43	–
	N_OV	0.30	0.37	0.38	0.39	0.33	–
$W_{0.88}Re_{0.88}$	λ	0.66	0.85	0.88	0.88	0.74	0.70
	μ^*	0.11	0.12	0.12	0.12	0.11	–
	T_C (K)	7.47	12.98	13.85	13.93	9.86	7.47
	α	0.44	0.45	0.46	0.46	0.45	–
	N_OV	0.34	0.41	0.42	0.42	0.38	–

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SUPRAVADAMĪBAS EFEKTA PĒTĪJUMI BINĀRO SAKAUSĒJUMU PĀREJAS METĀLOS, IZMANTOJOT PSEIDOPOTENCIĀLA TEORIJU

Aditay M. Vora

K o p s a v i l k u m s

Supravadoša stāvokļa parametri (SSP) (t.i.., elektronu-fononu sakabes stiprība λ, Kulona pseidopotenciāls μ^*, pārejas temperatūra T_C, izotopu efektu eksponents α un efektīvais savstarpējais spēks $N_O V$) bināro sakausējumu pārejas metāliem ir pētīta, izmantojot pirmo reizi pseido-atoma sakausējuma modeli potenciāla formālisma ietvaros. Pētījumā atklāta manāma dažādu apmaiņas un korelācijas funkciju ietekme uz λ un μ^*. Konstatēts, ka SSP rezultāti kvalitatīvi ir saskaņā ar pieejamiem eksperimentāliem datiem.

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