ISOTROPY OF INTERMETALLIC COMPOUNDS

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ABSTRACT:

The norm of elastic constant tensor and the norms of the irreducible parts of the elastic constants of Intermetallic compounds are calculated. The relation of the scalar parts norm and the other parts norms and the anisotropy of these compounds are presented. The norm ratios are used to study anisotropy of these compounds.

Index Terms *–Intermetallic Compounds Isotropy, Norm, Anisotropy, and Elastic Constants.*

1. INTRODUCTION

The decomposition procedure and the decomposition of elastic constant tensor is given in [1,2,3,4,5,6] , also the definition of norm concept and the norm ratios and the relationship between the anisotropy and the norm ratios are given in [3,4,5,6]. As the ratio becomes close to one the material becomes more isotropic, and as the ratio becomes close to one the material becomes more anisotropic as explained in [3,4,5,6] .

2. CALCULATİONS

Table 1, Elastic Constants (GPa), [7]

Cubic System, Intermetallic Compounds	c_{11}	c_{44}	c_{12}
$CaAl_2$	97.0	36.6	22.4
CoPt	290	124	178
Cu_3Au	191	66.3	138
$CuAuZn_2$	136	52.9	130
$GdAl_2$	160.5	59.5	36.8

$AuGa_2$	100.2	29.9	73.4
AuZn (50 at % Zn)	141.8	54.5	126.3
AuZn (47 at % Zn)	138	52	126
$HfCO_2$	256	90.3	123
$LaAl_2$	143.7	43.0	32.0
LiIn	55.9	26.7	41.7
$MgCu_2$	123	41.2	70.6
Mg_2Pb	71.7	30.9	22.1
Mg_2Sn	82.4	36.6	20.8
$NdAl_2$	141	42.8	47.0
Nb_3Sn	254	39.6	112
NiAl	212	112	143
Ni_3Al	169	121	89
Ni_3Fe (73.8 at %Ni)	230	119	114
$PrAl_2$	138	45.2	41.8
AgMg	83.8	47.6	56.4
$TbAl_2$	144	68	33
UCd_{11}	100.7	32.8	35.8
UCO_2	219	65.4	127
YAl_2	170.8	56.2	34.0
YZn	94.4	47.3	46.0
$ZrCO_2$	233	83.7	113

Table 2, the norms and norm ratios

By using table 1, and the decomposition of the elastic constant tensor [1,2,3,4,5,6], we have calculated the norms and the norm ratios as is shown in table 2.

Cubic System, Intermetallic Compounds	N_s	N_d	N_n	N	$\frac{N_s}{N}$	$\frac{N_d}{N}$	$\frac{N_n}{N}$
UCd_{11}	203.521	0	0.6416	203.522	1.0000	0	0.0032
$CaAl_2$	187.266	0	1.2831	187.271	1.0000	0	0.0069
$GdAl_2$	308.198	0	4.3076	308.228	0.9999	0	0.0140
$PrAl_2$	269.719	0	5.3158	269.771	0.9998	0	0.0197
$NdAl_2$	277.467	0	7.6987	277.574	0.9996	0	0.0277
Mg_2Sn	168.233	0	10.632	168.568	0.9980	0	0.0631
UCO_2	510.172	0	35.561	511.409	0.9976	0	0.0695
YAl_2	313.152	0	22.363	313.949	0.9975	0	0.0712
Mg_2Pb	149.474	0	11.181	149.892	0.9972	0	0.0746
$HfCO_2$	569.207	0	43.993	570.905	0.9970	0	0.0771
$TbAl_2$	296.241	0	22.913	297.126	0.9970	0	0.0771
$ZrCO_2$	520.841	0	43.443	522.65	0.9965	0	0.0831
$LaAl_2$	261.976	0	23.554	263.033	0.9960	0	0.0895
$MgCu_2$	288.844	0	27.495	290.150	0.9955	0	0.0948
Nb_3Sn	508.342	0	57.557	511.590	0.9937	0	0.1125
$AuGa_2$	258.806	0	30.245	260.568	0.9932	0	0.1161
Cu_3Au	495.993	0	72.955	501.329	0.9894	0	0.1455
CoPt	721.380	0	124.650	732.069	0.9854	0	0.1703
YZn	225.120	0	42.343	229.068	0.9828	0	0.1848
Ni_3Fe (73.8 at	555.162	0	111.810	566.310	0.9803	0	0.1974

%Ni)							
AuZn (47 at % Zn)	405.609	0	84.319	414.28	0.9791	0	0.2035
AuZn (50 at % Zn)	411.885	0	85.694	420.705	0.9790	0	0.2037
$CuAuZn_2$	410.794	0	91.468	420.854	0.9761	0	0.2173
LiIn	152.700	0	35.927	156.869	0.9734	0	0.2290
AgMg	226.710	0	62.140	235.072	0.9644	0	0.2643
NiAl	559.666	0	170.470	585.053	0.9566	0	0.2914
Ni_3Al	454.707	0	148.480	478.334	0.9506	0	0.3104

3. CONCLUSION

By examining the results which are given in table 2, we can conclude by considering the ratio that the compound UCd11 is the most isotropic compound (because the value of in the case of UCd11 is more small than that in the case of CaAl2), and the most anisotropic Intermetallic compound is Ni3Al because the value of is the smallest and value of is the largest for Ni3Al, and also we can notice that in the case of the Intermetallic compounds (CaAl2, GdAl2, PrAl2, NdAl2, YAl2, TbAl2, and LaAl2) which every one of them contain two atoms of Aluminium, Al, the most isotropic compound is CaAl2 and LaAl2 is the most anisotropic compound, and also we can notice that in case of the compounds, AuZn (47 at % Zn), and AuZn (50 at % Zn), the former one with less % Zn is more isotropic, and also we can notice that the Intermetallic compound UCO2 is the most isotropic compound of the compounds (UCO2, HfCO2, and ZrCO2) where ZrCO2 is the most anisotropic compound, also we can notice by considering the value of we found that this value is the highest (721.380) in the case of the Intermetallic compound CoPt so we can say that the Intermetallic compound CoPt elastically is the strongest, and the in the case of Mg2Pb (149.474) the value of is the smallest so we can say that the Intermetallic compound Mg2Pb elastically is the least strong compound.

REFERENCES

[1] Jerphagnon, J., Chemla, D. S., and Bonnevile, R., (1978), "The Description of Condensed Matter Using Irreducible Tensors", Adv. Phys, 11, p1003-1017.

[2] Radwan, Fae'q A. A. (1999), " Norm Ratios and Anisotropy Degree", The First International Conference in Mathematical Sciences, Applied Mathematics, ICM99, November 1999, United Arab Emirates University, Al Ain, United Arab Emirates. Pak. J. Appl. Sci..Vol. 1, (3): 301-304, 2001.

[3] F. A. A. Radwan, 'Scalar Irreducible Parts of Sixth Rank Tensor', Arab Gulf Journal of Scientific Research, 19 (3), Pp163-166, (2001).

[4] Fae`q A. A. Radwan, ' Some Properties of Copper - Gold and Silver - Gold Alloys at Different % of Gold', Journal: Lecture Notes in Engineering and Computer Science Year: 2011, Vol 2189, Issue: 1, pp1221-1224.

[5] Fae`q A. A. Radwan, ' Isotropy of Some Types of Bones`, International Journal of Engineering Science and Technology (IJEST), Vol. 3 No. 4 April 2011: 3382-3386.

[6] Fae’q A. A. Radwan, ‘Some properties of copper-nickel at different % of Ni’, Pelagia Research Library, Der Chemica Sinica, 2014, 5(1):34-38.

[7] Landolt-Börnstein, Group III, "Crystal and Solid State Physics", Volume, 11, Springer-Verlag.