International Journal of Scientific Research in Chemistry (IJSRCH) | Online ISSN: 2456-8457
© 2018 IJSRCH | Volume 3 | Issue 4

Anisotropy of Single Crystal Magnesium Lithium Binary Alloys

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ABSTRACT

The norm of elastic constant tensor and the norms of the irreducible parts of the elastic constants of the single crystal magnesium lithium alloys Mg-Li at two different percentages (wt. %) of lithium are calculated. The relation of the scalar parts norm and the other parts norms and the anisotropy of these alloys are presented. The norm ratios are used as a criterion to present the anisotropy degree of these alloys.

Keywords : Single Crystal, Norm, Anisotropy, Elastic Constants, Magnesium-Lithium Alloys, Irreducible parts, and Binary Alloys.

I. INTRODUCTION

It was settled that the biocompatibility and biodegradability of binary alloys Mg-Li together with medium modulus of elasticity, and a good corrosion resistance offer binary magnesium-lithium alloys hopeful for use in bio-medical applications [1] and the high strength together with low density of magnesium lithium alloys makes them likable to use in the aerospace and transportation industries [2]. The decomposition procedure and the decomposition of elastic constant tensor (Elastic constant tensor can be decomposed into two scalar parts, two deviator parts and one nonor part) is given in [3,4], 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]. As the ratio N_s / N (Norm of the scalar part of the elastic constant tensor/Norm of the elastic constant tensor) becomes close to one the material becomes more isotropic, and as the sum of the ratios N_d / N (Norm of the deviator part of the elastic constant tensor/Norm of the elastic constant tensor) and N_n / N (Norm of the nonor part of the elastic constant tensor/Norm of the elastic constant tensor) becomes close to one the material becomes more anisotropic as explained in [3-15].

II. DATA AND CALCULATIONS

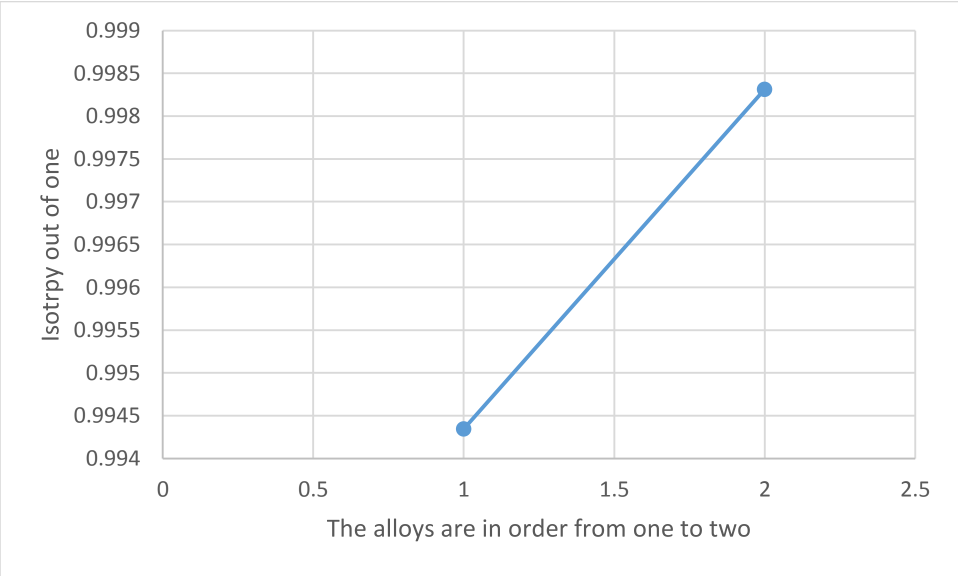
Table 1. Elastic constants in GPa

single crystal magnesium lithium binary alloy	C_{11}	C_{12}	C_{13}	C_{33}	C_{44}
Magnesium lithium binary alloy, Mg-Li at (wt. %) Li.					
5.0, [16]	51.2	20.1	17.1	64.7	19.8
15.0, [17]	92.0	10.0	5.0	103.0	42.0

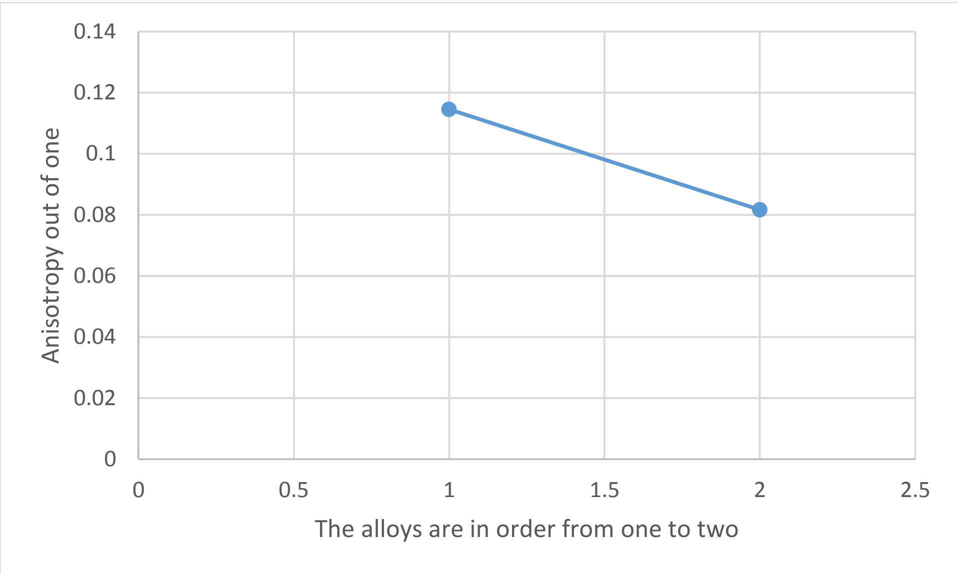
By using table 1, and the decomposition of the elastic constant tensor and the norm concept we can calculate the norms and the norm ratios of the given alloys as in the following table.

Table 2. The norms and norm ratios (the anisotropy degree).

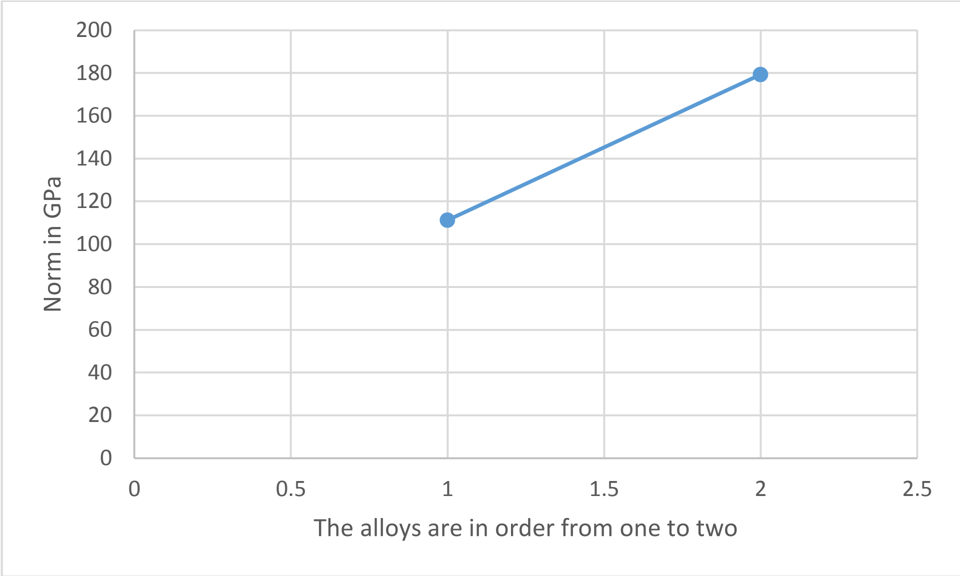
Single crystal magnesium lithium binary alloy	N_s	N_d	N_n	N	N_s / N	N_d / N	N_n / N	Sum of the last two columns
Magnesium lithium binary alloy, Mg-Li at (wt. %) Li. 5.0								
	110.5927	11.7737	0.960973	111.2218	0.994344	0.105858	0.00864	0.114498
15.0	178.9727	8.101398	6.534617	179.2751	0.998313	0.04519	0.03645	0.08164



Graph 1. Isotropy Degree.



Graph 2. Anisotropy Degree.



Graph 3. Elastically Srong.

III. RESULTS AND CONCLUSION

From table 2 and the Graphs (Graph 1 to Graph 3), and analysing the ratio N_s / N we can conclude that Magnesium lithium binary alloy, Mg-Li at (wt. 15%) of Li.is the most isotropic alloy with highest value of N_s / N (0.998313) and lowest sum value of N_d / N and N_n / N (0.08164), and Magnesium lithium binary alloy, Mg-Li at (wt. 5%) of Li is the most anisotropic alloy with highest sum value of N_d / N and N_n / N (0.114498), and with lowest value of N_s / N (0.994344), because for isotropic material $N_s / N = 1$, and the sum value of N_d / N and N_n / N (= 0). Which means that as the sum value of N_d / N and N_n / N increases the anisotropy increases. And also the elastically strongest alloy is Magnesium lithium binary alloy, Mg-Li at (wt. 15%) of Li, which has the highest value of N (179.2751), which means that as the (wt. %) of Li increases the isotropy and the elastically strong increase.

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