ANISOTROPY AND ISOTROPY DEGREES OF MgO And $MgSiO_4$ AT DIFFERENT TEMPERATURES

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Abstract:

The norm of elastic constant tensor and the norms of the irreducible parts of the elastic constants of $\mathbf{MgO}$ and $\mathbf{MgSiO_4}$ at different temperatures along with the experimental data obtained under adiabatic condition. The relation of the scalar parts norms and the other parts norms and the anisotropy of these materials is presented. The norm ratios are used as a criterion to present the anisotropy degree of the properties of these.

Key Words $\mathbf{MgO}$, $\mathbf{MgSiO_4}$, Norm, Anisotropy, Elastic Constants, and Irreducible parts.

1 – Introduction:

Anisotropy and Isotropy: when the properties of a material vary with different crystallographic orientations, the material is said to be **anisotropic,** common examples of anisotropic materials are wood and composites. Alternately, when the properties of a material are the same in all directions, the material is said to be **isotropic**. The decomposition procedure and the decomposition of elastic constant tensor is given in [1], also the definition of norm concept and the norm ratios and the relationship between the anisotropy and the norm ratios are given in [1]. As the ratio N_s/N becomes close to one the material becomes more isotropic, and as the sum of N_d/N and N_n/N becomes close to one the material becomes more anisotropic as explained in [1-6].

2 – Data and Calculations

Table 1. Elastic constants in GPa, for $\mathbf{MgO}$: Calculated values of $\mathbf{C_{11}}$,$\mathbf{C_{12}}$, and $\mathbf{C_{44}}$ (in GPa) at different temperatures along with the experimental data obtained under adiabatic condition [7].

T [K]	C_{11}	C_{12}	C_{44}
300	298.96	96.42	157.13
400	293.11	97.17	155.87
600	281.41	98.67	153.35
800	269.72	100.17	150.83
1000	258.05	101.66	148.31
1200	246.39	103.16	145.79
1400	234.78	104.16	143.27
1600	223.22	106.16	140.76
1800	211.75	107.66	138.24

Table 2. Elastic constants in GPa, for $MgSiO_4$: Calculated values of C_{11},C_{12}, and C_{44} (in GPa) at different temperatures along with the experimental data obtained under adiabatic condition [7].

T [K]	C_{11}	C_{22}	C_{33}	C_{44}	C_{55}	C_{66}	C_{23}	C_{31}	C_{12}
300	330.0	200.0	236.0	67.2	81.5	81.2	71.2	68.0	66.2
500	322.7	194.5	230.2	64.5	78.6	77.9	70.0	66.1	64.0
700	315.4	189.0	224.4	61.7	75.6	74.6	68.7	64.2	61.9
900	308.1	183.5	218.7	59.0	72.7	71.3	67.5	62.3	59.7
1100	300.9	177.9	212.9	56.2	69.8	68.0	66.2	60.5	57.6
1300	293.6	172.4	207.1	53.5	66.9	64.7	65.0	58.6	55.4
1500	286.3	166.9	201.4	50.8	64.0	61.4	63.8	56.7	53.3
1700	279.0	161.5	195.6	48.1	61.0	58.3	62.5	54.8	51.1

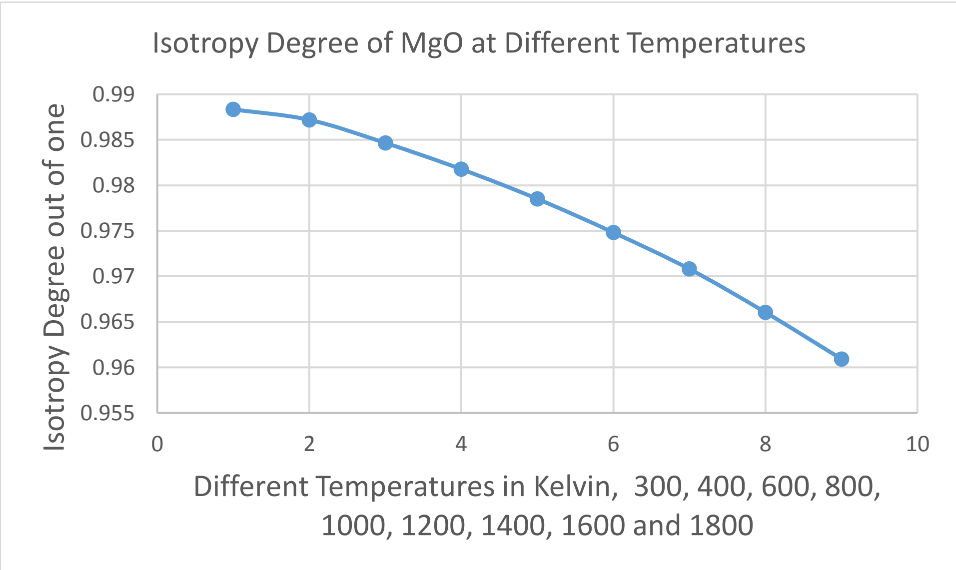
By using table 1 and table 2, and the decomposition of the elastic constant tensor and the norm concept, the norms and the norm ratios of the given materials can be calculated as in table 3 and table 4.

Table 3. The norms and norm ratios of MgO.

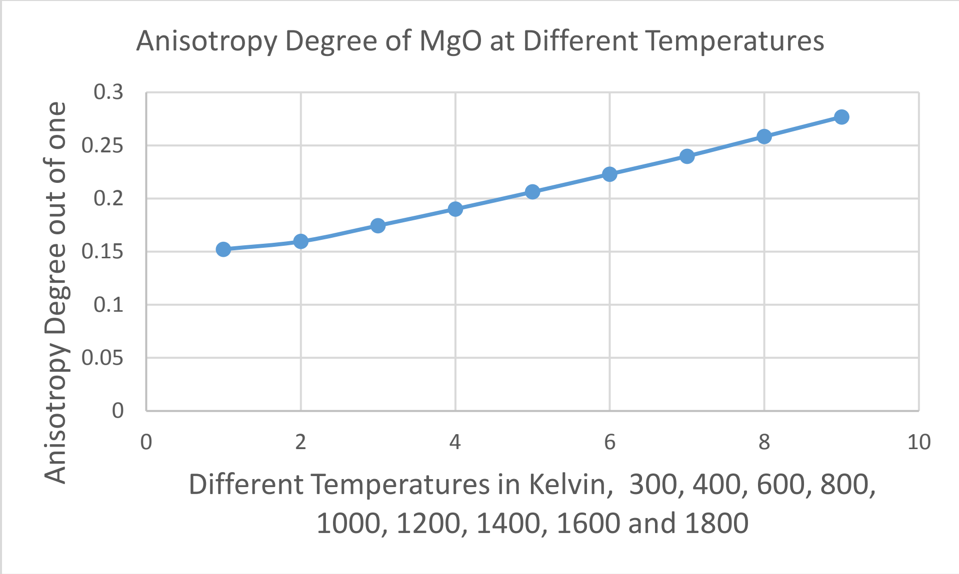
T[K]	N_s	N_d	N_n	N	$\frac{N_s}{N}$	$\frac{N_d}{N}$	$\frac{N_n}{N}$
300	**664.6105**	**0**	**102.393**	**672.4519**	**0.988339**	**0**	**0.152268**
400	**656.764**	**0**	**106.1325**	**665.2841**	**0.987193**	**0**	**0.15953**
600	**641.0931**	**0**	**113.6112**	**651.082**	**0.984658**	**0**	**0.174496**
800	**625.4656**	**0**	**121.0808**	**637.0776**	**0.981773**	**0**	**0.190057**
1000	**609.8852**	**0**	**128.5229**	**623.2801**	**0.978509**	**0**	**0.206204**
1200	**594.3641**	**0**	**135.965**	**609.7173**	**0.974819**	**0**	**0.222997**
1400	**578.3888**	**0**	**142.903**	**595.7809**	**0.970808**	**0**	**0.239858**
1600	**563.6361**	**0**	**150.7301**	**583.4425**	**0.966052**	**0**	**0.258346**
1800	**548.4714**	**0**	**157.998**	**570.7751**	**0.960924**	**0**	**0.276813**

Table 4. The norms and norm ratios of MgSiO4.

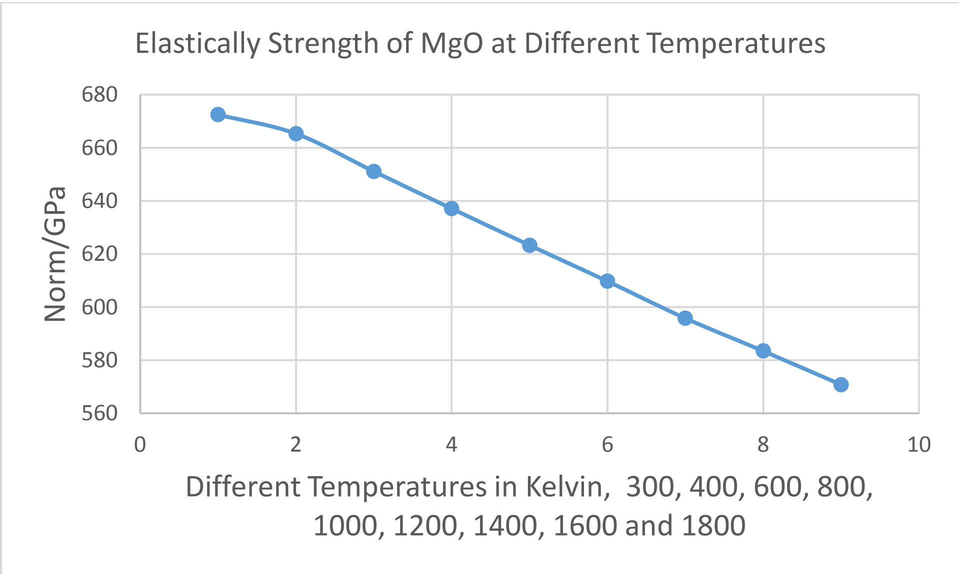
T[K]	N_s	N_d	N_n	N	$\frac{N_s}{N}$	$\frac{N_d}{N}$	$\frac{N_n}{N}$	Sum of $\frac{N_d}{N}$ and $\frac{N_n}{N}$
300	**457.6629**	**87.3537**	**31.7451**	**467.0051**	**0.979996**	**0.187051**	**0.067976**	0.255027
500	**445.4374**	**85.83539**	**32.9551**	**454.8277**	**0.979354**	**0.188721**	**0.072456**	0.261177
700	**433.1592**	**84.36747**	**34.2559**	**442.6265**	**0.978611**	**0.190606**	**0.077392**	0.267998
900	**420.9827**	**82.84554**	**35.514**	**430.5242**	**0.977837**	**0.192429**	**0.082491**	0.27492
1100	**408.7936**	**81.56039**	**36.7376**	**418.4662**	**0.976886**	**0.194903**	**0.087791**	0.282694
1300	**396.5916**	**80.06995**	**37.9930**	**406.3737**	**0.975928**	**0.197035**	**0.093493**	0.290528
1500	**384.4837**	**78.57368**	**39.24998**	**394.3882**	**0.974886**	**0.199229**	**0.099521**	0.29875
1700	**372.3141**	**77.0708**	**40.50102**	**382.3585**	**0.97373**	**0.201567**	**0.105924**	0.307491



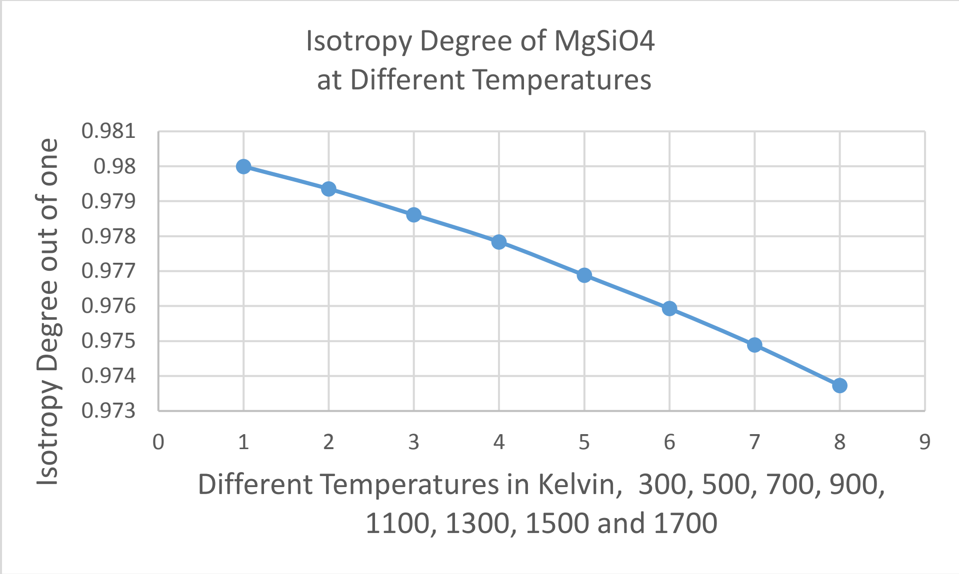
Graph 1. Isotropy Degree.



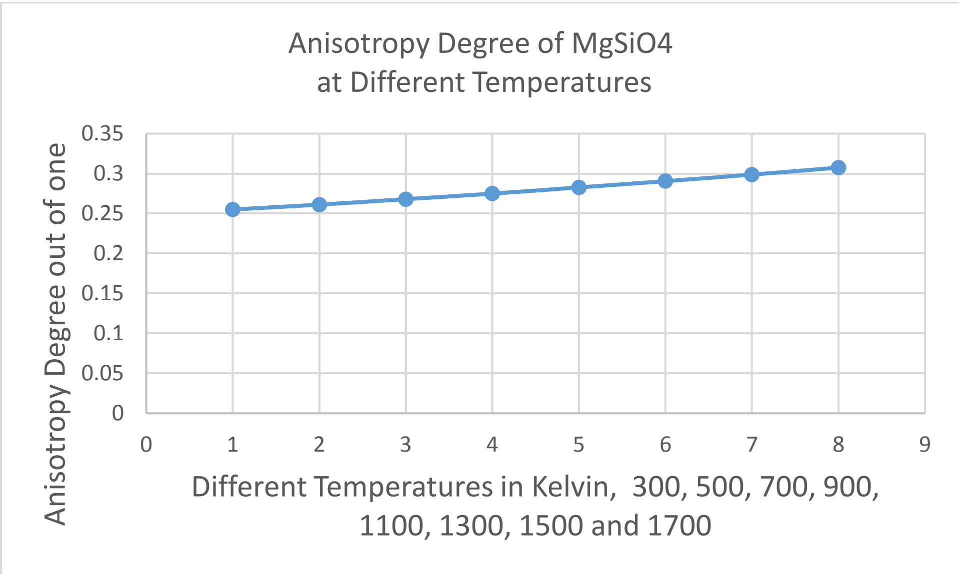
Graph 2. Anisotropy Degree.



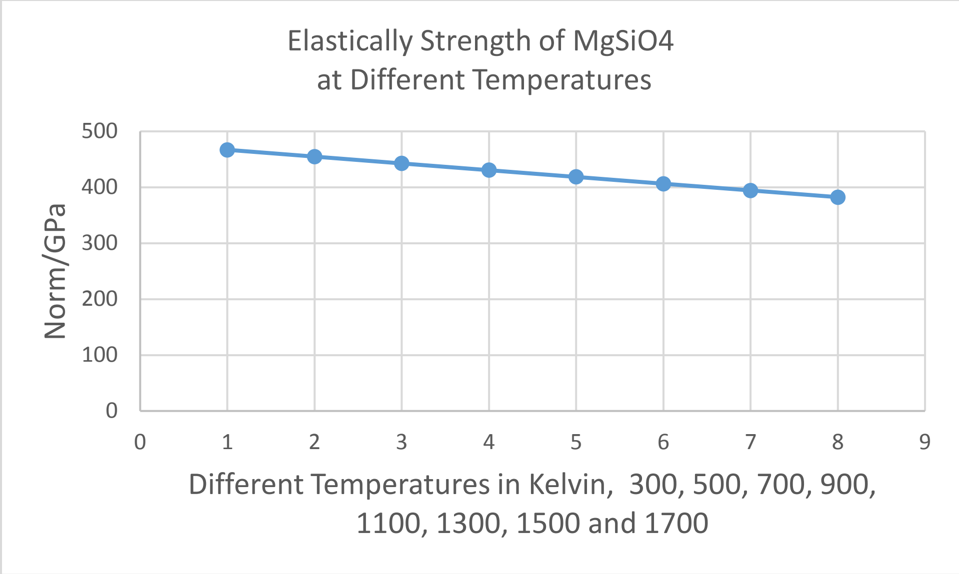
Graph 3. Elastically Strength.



Graph 4. Isotropy Degree.



Graph 5. Anisotropy Degree.



Graph 6. Elastically Strength.

3 - Conclusion:

From table 3 and table 4 and the Graphs (Graph 1 to Graph 6), and analyzing the ratio $\mathbf{N_s /N}$ for different temperatures in Kelvin for MgO and $MgSiO_4$ we can conclude that the value of $\mathbf{N_s /N}$ (isotropy degree) decreases as the temperature increases and the sum of the values of $\mathbf{N_d /N}$ and $\mathbf{N_n /N}$ (Anisotropy degree) increases as the temperature increases, and also the value of **N** (elastically strength) decreases as the temperature increases.

4 - References:

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