Some Physical Properties of Cubic System Miscellaneous Compounds

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Abstract

The norm of elastic constant tensor and the norms of the irreducible parts of the elastic constants of different types of cubic system miscellaneous compounds are calculated. The relation of the scalar parts norm and the other parts norms and the anisotropy of these compounds are characterized. The norm ratios are used to study anisotropy of these compounds.

Index Terms: Isotropy, Norm, Anisotropy, and Elastic Constants.

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Introduction

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 [1-4], also the definition of norm concept and the norm ratios and the relationship between the anisotropy and the norm ratios are given in [1-5]. 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 [1-5]. We planned to study the isotropy of different types of solid solutions because when the properties of a material vary with different crystallographic orientations, the material is said to be anisotropic. Alternately, when the properties of a material are the same in all directions, the material is said to be isotropic.

1. Data and Calculations

Table 1, Elastic Constants (GPa), [6]

Compound	C_{11}	C_{44}	C_{12}
Adamanatane, $C_{10}H_{16}$	6.15	3.40	3.02
Ammonium bromide, NH_3Br	33.8	6.85	9.1
Ammonium chloride, NH_4Cl	38.1	8.63	9.37
Ammonium chlorostannate, $(NH_4)_2SnCl_2$	21.7	10.6	9.5
Ammonium iodide, NH_4I	24.5	2.40	4.28
Barium dicalcium propionate, $BaCa_2(C_2H_5CO_2)_6$	7.64	2.85	4.50
Barium nitrate, $Ba(NO_3)_2$	29.3	12.8	20.6
Barium titanate (piezoel.), $BaTiO_3$	206	126	140
Bismuth germinate (piezoel.), $Bi_4(GeO_4)_3$	116	43.6	27
Bismuth germanium oxide (piezoel.), $Bi_{12}GeO_{20}$	125	25.6	33
Bismuth silicate (piezoel.), $Bi4(GeO_4)_3$	136	51.8	23
Caesium cadmium fluoride, $CsCdF_3$	108	25.0	40
Caesium lead chloride, $CsPbCl_3$	28.3	5.08	15.2

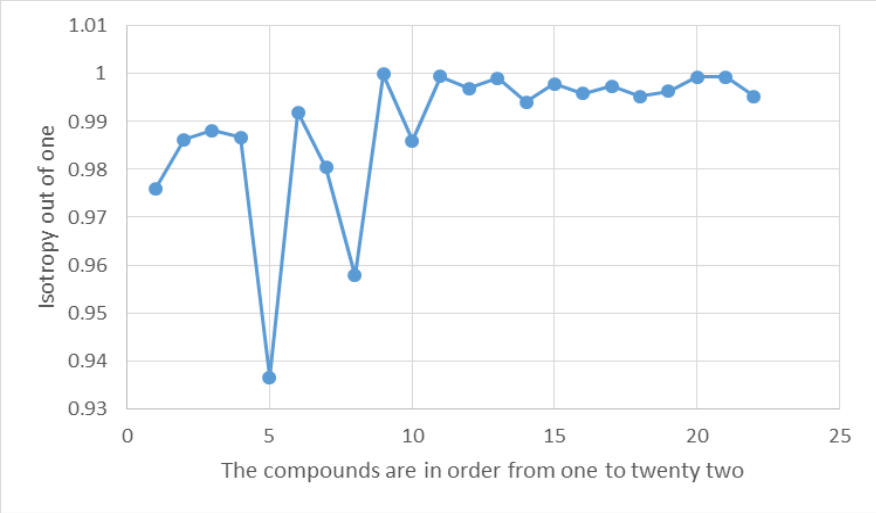
Chromite, $FeOCr_2O_3$	322	117	144
Cobalt zinc ferrite, $Co_{0.32}Zn_{0.22}Fe_{2.2}O_4$	266	78	153
Cyanospinels, $K_2X(CN)_4$			
X = Zn	22.49	3.28	11.23
Cd	18.04	2.52	9.93
Hg (Ultrasonic)	17.68	2.30	9.12
Hg (Brillouin)	17.84	2.34	9.60
Diammonium dicadmium sulfate (piezoel.), $(NH_4)_2Cd_2(SO_4)_3$	76.6	20.4	29.5
Dipotassium dimagneium sulfate (Langbeinite) (piezoel.), $K_2Mg_2(SO_4)_3$	110	33.8	34.0
Dithallium dicadmium sulfate (piezoel.), $Tl_2Cd_2(SO_4)_3$	64	23	6

By using and the decomposition of the elastic constant tensor, the norms and the norm ratios calculated are as is shown in table 2.

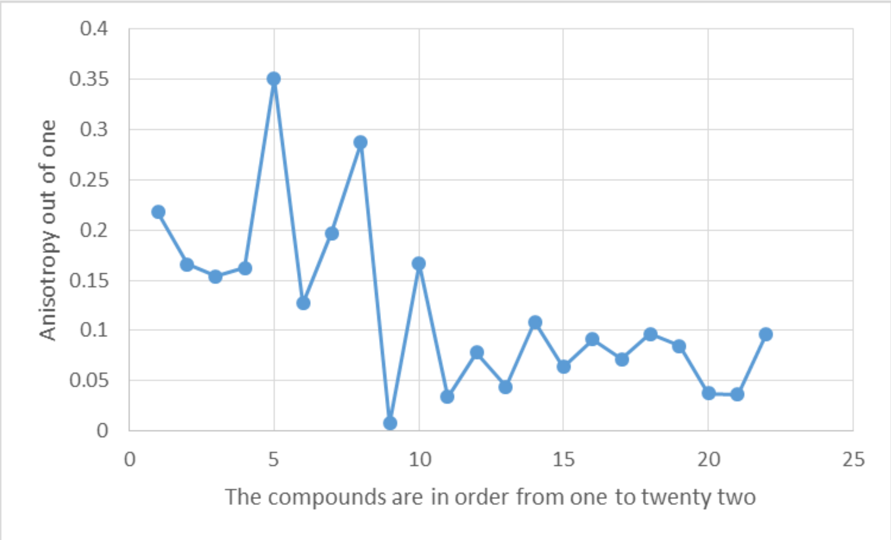
Table 2, the norms and norm ratios

Compound	N_s	N_d	N_n	N	$\frac{N_s}{N}$	$\frac{N_d}{N}$	$\frac{N_n}{N}$
Adamanatane, $C_{10}H_{16}$	**15.059**	**0**	**3.364**	**15.430**	**0.9759**	**0**	**0.2180**
Ammonium bromide, NH_3Br	60.041	0	10.082	60.882	0.9862	0	0.1656
Ammonium chloride, NH_4Cl	67.405	0	10.512	68.220	0.9881	0	0.1541
Ammonium chlorostannate, $(NH_4)_2SnCl_2$	50.083	0	8.249	50.758	0.9867	0	0.1625
Ammonium iodide, NH_4I	**37.733**	**0**	**14.133**	**40.293**	**0.9365**	**0**	**0.3507**
Barium dicalcium propionate, $BaCa_2(C_2H_5CO_2)_6$	18.358	0	2.346	18.507	0.9919	0	0.1268
Barium nitrate, $Ba(NO_3)_2$	77.113	0	15.489	78.653	0.9804	0	0.1969

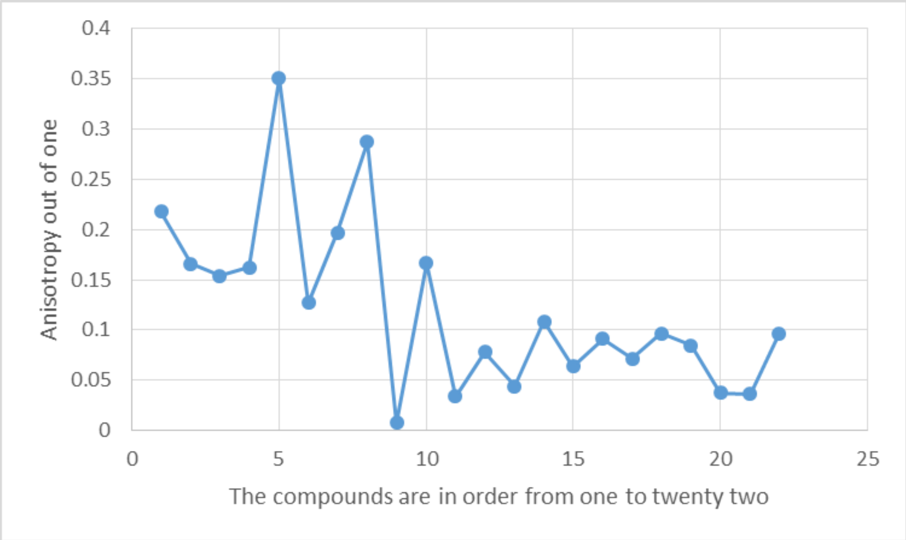
Barium titanate (piezoel.), $BaTiO_3$	568.274	0	170.472	593.293	0.9578	0	0.2873
Bismuth germinate (piezoel.), **$Bi_4(GeO_4)_3$**	**223.958**	**0**	**1.650**	**223.964**	**0.99997**	**0**	**0.00736**
Bismuth germanium oxide (piezoel.), $Bi_{12}GeO_{20}$	221.400	0	37.394	224.536	0.9860	0	0.1665
Bismuth silicate (piezoel.), Bi4$(GeO_4)_3$	254.600	0	8.615	254.745	0.99943	0	0.033820
Caesium cadmium fluoride, $CsCdF_3$	210.574	0	16.497	211.220	0.99694	0	0.07810
Caesium lead chloride, $CsPbCl_3$	61.637	0	2.695	61.695	0.99905	0	0.04368
Chromite, $FeOCr_2O_3$	**698.337**	**0**	**76.071**	**702.468**	**0.99412**	**0**	**0.10829**
Cobalt zinc ferrite, $Co_{0.32}Zn_{0.22}Fe_{2.2}O_4$	616.574	0	39.410	617.833	0.99796	0	0.06379
Cyanospinels, $K_2X(CN)_4$							
X = Zn	47.079	0	4.308	47.275	0.99584	0	0.09112
X = Cd	39.2995	0	2.814	39.400	0.99744	0	0.07141
X = Hg (Ultrasonic)	37.355	0	3.629	37.531	0.99531	0	0.09670
X = Hg (Brillouin)	38.398	0	3.263	38.537	0.99641	0	0.08467
Diammonium dicadmium sulfate (piezoel.), $(NH_4)_2Cd_2(SO_4)_3$	153.454	0	5.774	153.562	0.99929	0	0.03760
Dipotassium dimagneium sulfate (Langbeinite) (piezoel.), $K_2Mg_2(SO_4)_3$	213.380	0	7.699	213.519	0.99935	0	0.03606
Dithallium dicadmium sulfate (piezoel.), $Tl_2Cd_2(SO_4)_3$	113.458	0	10.998	113.990	0.99533	0	0.09648



Graph 1. Isotropy Degree.



Graph 2. Anisotropy Degree.



Graph 3. Elastically Srong.

3. Conclusion and Results

From table 2 and the Graphs (Graph 1 to Graph 3), and analyzing the ratio N_s /N we can conclude that Bismuth germinate (piezoel.), $Bi_4(GeO_4)_3$ is the most isotropic material with highest value of N_s /N (0.99997) and lowest value of N_n /N (0.00736), and Ammonium iodide, NH_4I, is the most anisotropic material with highest value of N_n /N (0.3507) and with lowest value of N_s /N (0.9365), because for isotropic material N_s /N = 1, and N_d /N = 0 and N_n /N = 0. Which means that as the value of N_n /N increases the anisotropy increases? And also, the elastically strongest material is Chromite, $FeOCr_2O_3$, which has the highest value of. N (702.468), and the elastically lowest strongest is Adamanatane, $C_{10}H_{16}$, which has the lowest value of N (15.430).

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