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Power factor profile of NiO

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Abstract- This paper is providing the power factor profile of undoped bulk Nickel Oxide. Nickel oxide is a transition metal oxide having many interesting properties and also has application in various fields such as thermoelectric power generation. In thermoelectric power generation the efficiency of the material is depend upon the figure of merit (ZT) of the used material. Figure of merit of the material is expressed as ZT= (S2σ/k) T where S2σ is known as power factor and k is the thermal conductivity of the material. Thus in this paper we have analyze the power factor of the nickel oxide at different temperature ranges and with the help of this we can find out the figure of merit.

Index Terms- power factor, figure of merit, thermoelectric material, electrical conductivity, thermo power etc.

I. INTRODUCTION

Thermoelectric power generation has become an attractive area for the researchers due to huge requirement of energy and waste heat recovery. Our present work is also concentrated in this area with material NiO. High performance thermoelectric devices made by thermoelectric material having high seeback coefficient, high electrical conductivity and low thermal conductivity. Existing materials which are used for the thermoelectric conversion such as Bi_2Te_3, SbTe or PbTe are efficient but these are not works at high temperatures (above 600-800^{0}c) and toxic also. [1] NiO is non toxic material and works efficiently up to very high temperatures these properties make it favorable for thermoelectric power generation. Thermoelectric power generation depends upon the figure of merit of the material ZT= (S^2 *σ/k) T, where s is the seeback coefficient, σ is the electrical conductivity and k is the thermal conductivity. This figure of merit is directly proportional of the factor S^2 *σ which is known as the power factor of the material. [3]In this paper we studied the power factor of the NiO sample at the different temperatures and analyzed the data with the help of graph plotted between temperature and power factor S^2 *σ.

II. METHODOLOGY

As per the recorded data for undoped NiO by Keem et al [4], we calculated some of the other parameters such as power factor and figure of merit at different temperatures. All the given data provided us the bulk characteristics of NiO up to the temperature range 700 K. For the above purpose the used formula is

Power factor=S^2 *σ
Figure of merit ZT= (S^2 *σ/k) T

III. RESULTS AND DISCUSSION

Between the temperature ranges 300 -800 K we have some of the values of seeback coefficient, thermal conductivity and electrical conductivity of undoped NiO. With the help of this data we can calculate the power factor of the NiO sample at the given temperature range. [4]

TABLE: I

T (K)	S(mV/K)	k	S^2	σ($\Omega^{-1}cm^{-1}$)	S^2 *σ ($mWcm^{-1}K^{-2}$)	ZT=(S^2 *σ/k) T
300	0.982	.202	0.964	0.0012	0.00156	.0077
400	0.797	.115	0.635	0.0026	0.00165	.0143
440	0.733	.108	0.537	0.011	0.0059	.0546
500	0.671	.078	0.45	0.049	0.022	.282
570	0.609	0.062	0.37	0.138	0.051	0.822
670	0.549	.045	0.299	0.303	0.09	2

700	0.475	.026	0.225	0.432	0.097	3.73
770	0.412	.020	0.169	0.504	0.085	4.25
800	0.375	.012	0.14	0.52	0.072	6

On the basis of above calculation we draw a graph between temperature and power factor which gives us information regarding efficiency of the undoped NiO material up to certain temperatures.

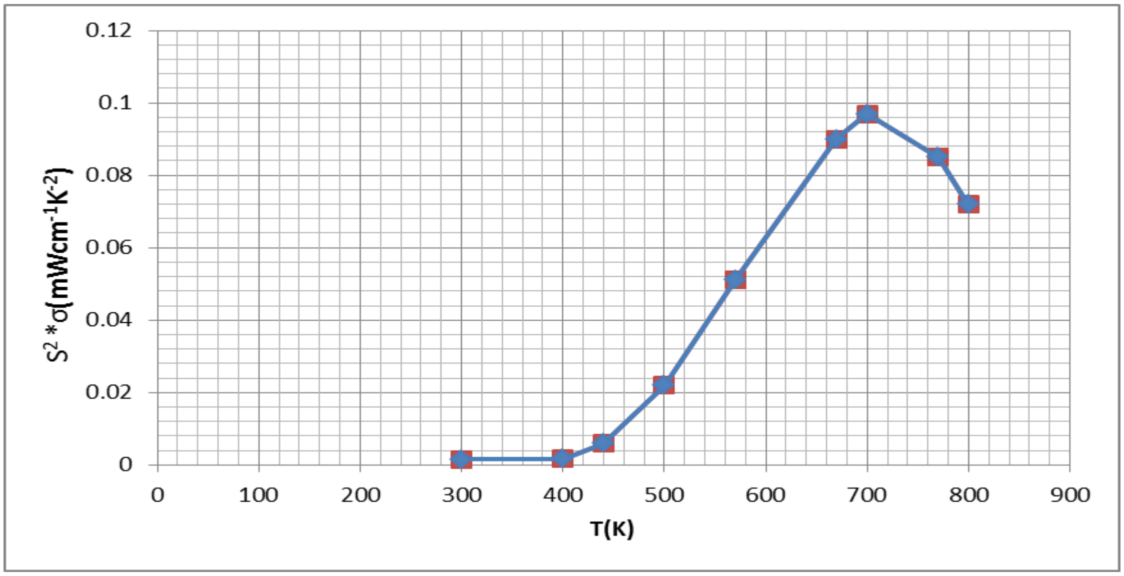

Fig. 1 Analyzing the graph we can conclude that at the temperature below 800K the power factor of the undoped nickel oxide is increases and above the 700K it decreases.

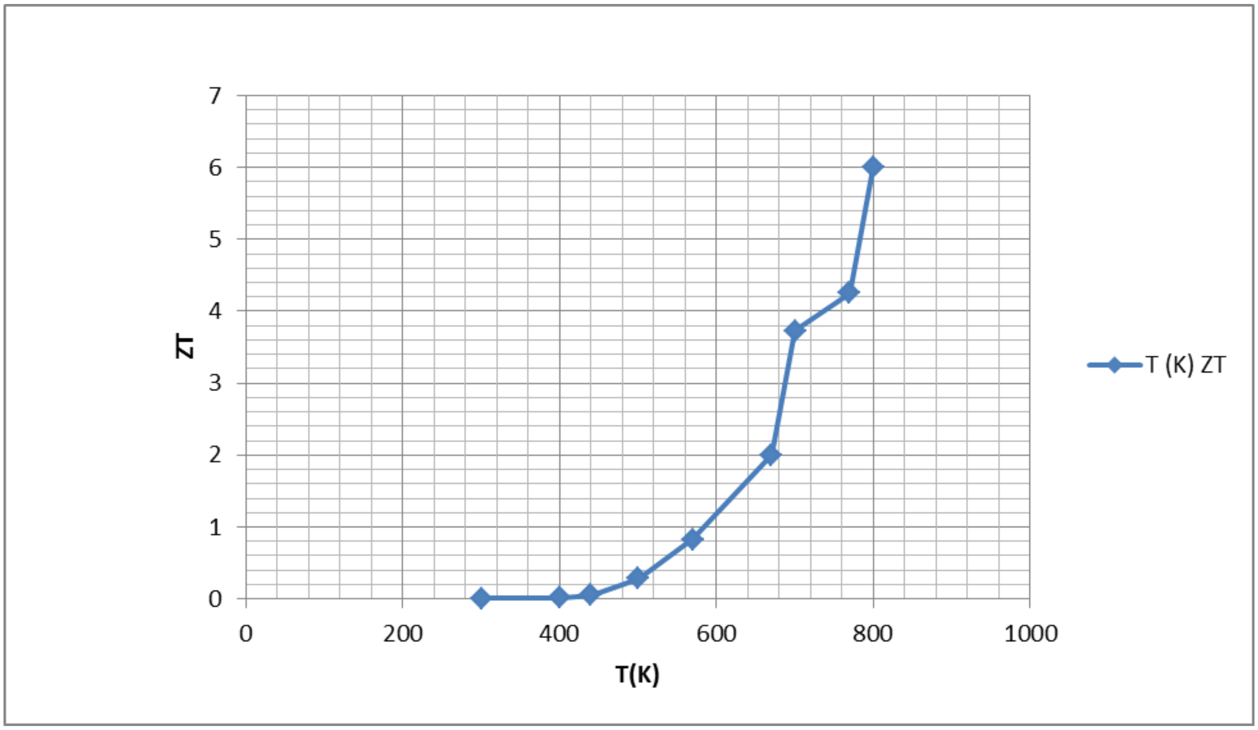

Fig. 2 analyzing the fig 2 we can say that as the temperature increases figure of merit of the NiO also increases because the thermal conductivity of NiO is decreases.

IV. Conclusion

By the above calculated data of the undoped NiO we can find out the increasing power factor up to 670K. After that it can decrease so for the better performing devices we must enhance the power factor of the NiO with the help of doping with some effective highly conductive material so we can get the good results for more applications.[5] on the other hand if the thermal conductivity is decreases figure of merit of the material increases weather the power factor increases or not. But major role play of power factor restricted us, thus we must enhance the power factor of the NiO with doping tool either by transition metal ions or metal having rare lattice defects.[6-7]one more fact is that the semiconductors are good thermoelectric materials and when we reduces the dimensions of the NiO at the nanoscale it turns to p type semiconducting material having indirect band gap. So we can use this material for the better performing thermoelectric devices.

References

[1] shin nishiyama,takahiro ushijima. 1-33 yayoi,inage-ku chiba 263-8522,japan, TENDENCIES OF P-TYPE THERMOELECTRIC OXIDE SEMICONDUCTOR

[2] STRUCTURAL AND ELECTRICAL PROPERTIES OF ANNEALED NICKEL OXIDE (NiO) THIN FILMS PREPARED BY CHEMICAL BATH DEPOSITION, Journal of Ovonic Research ,Vol. 9, No. 1, January – February 2013, p. 9 – 15

[3] HIGH PERFORMANCE P-TYPE THERMOELECTRIC OXIDE BASED ON NiO. Materials Letters 45,2000. 302–306

[4] E. Keem and J. M Honi~g, SELECTED ELECTRICAL AND THERMAL PROPERTIES OF UNDOPED NICKEL OXIDE.

[5] P. Mallick1, N. C. Mishra2, EVOLUATION OF STRUCTURE, MICROSTRUCTURE, ELECTRIC AND MAGNETIC PROPERTIES OF NICKLE OXIDE (NiO) WITH TRANSITION METAL DOPING. American Journal of Materials Science 2012, 2(3): 66-71 DOI: 10.5923/j.materials.20120203.06

[6] Wei-Luen Jang a, Yang-Ming Lub, Weng-Sing Hwang a, Wei-Chien Chena, ELECTRICAL PROPERTIES OF Li DOPED NiO FILMS Journal of the European Ceramic Society 30 (2010) 503–508

[7] Joo-Hyoung Lee,1,4 Junqiao Wu,1,2,3 and Jeffrey C. Grossman, ENHANCING THE THERMOELECTRIC POWER FACTOR WITH HIGHLY MISMATCHED ISOELECTRONIC DOPING.PRL 104, 016602 (2010) physical review letters 8 January 2010

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