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Impact of Modeling and Simulation for Conductivity Measurements

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Abstract: Modeling and simulation techniques have opened the new windows to address various issues related with complex computations. Researchers belonging to different field viz. Economics, Physics, Biology etc. have been applying computer-aided simulated techniques in their research work. The modified mathematical model relevant to the present case has been taken into account. Further, simulation techniques become the essential tool to examine the behavior of the proposed system so as to explain and verify in the real-world situation. The present paper explores the aspects of modeling and simulation by discussing the measurements of the conductivity of YBCO superconductor materials by using the mathematical model for the numerical experimentation in the temperature range of 10K to 240K. By changing the value of one of the scattering strength, impact of modeling and simulation has also been observed.

Index Terms: Modeling, Simulation, YBCO Superconductor, and Conductivity.

I. INTRODUCTION

In knowing the behaviour of interacting parts or components of a system, modeling & simulation has become a discipline. In the present context, simulation generally refers to a computerized version of the model which is run over time to study the implications of the existing interactions. Peter Senge, in "The Fifth Discipline: The Art & Practice of the Learning Organization" talks about two types of complexity, detail and dynamic. Detail complexity is associated with systems which have many component parts. In the dynamic complexity, we can deal with the connections between the parts of the system and their interactions which otherwise becomes impossible. One of the great achievements in simulation is its ability to effect a time and space compression on the system. Researchers belonging to different field viz. Economics, Physics, Biology etc. have been applying computer-aided simulated techniques in their research work. Almost in every area, maybe it is physics, chemistry, biology or economics, applications of modeling and simulation have been carried out [1,2]. These efforts have become very useful in gaining insight into the functions occurred in the system taken into account.

Naylor, an economist, using models of economic systems, has applied simulation with new situation where little or no information is available. Naylor proposed twelve reasons so as to consider the simulation be useful for particular applications. In the present context, four of them are :(i) Simulation of complex systems can yield valuable insight into which variables are more important than there in the system and how these variables interact.(ii) Simulation can be used to experiment with new situations about which little or no information is available, so as to prepare for what may happen. (iii) Simulation can serve as a “pre-service test” to try out new policies and decision rules for operating a system, before running the risk of experimenting on the real system. (iv) When new elements are introduced into a system, simulation can be used to anticipate bottlenecks and other problems that may arise in the behaviour of the system.

Several advantages have been adjudged such as simulation allows controlled experimentation and time compression. Shannon described -" Simulation is the process of designing a computerized model of a system (or process) and conducting experiments with this model for the purpose of either understanding the behavior of the system or evaluating various strategies for the operation of the system".

Presently, thermal conductivity of YBCO superconductor has been evaluated using the simulation approach. Some of the previous approach for other material[3] have been extended in the present case of YBCO superconductor. Superconducting systems promise wide applications for the human welfare, particularly in the areas of communication, memory devices, medical scanners etc. [4, 5, 6].

Thus, the estimation of the thermal conductivity of $Yba_2Cu_3O_7$ superconductors has been a great interest among the researchers [7, 8]. Earlier mathematical models [9] were used in similar way using computer-aided technique to estimate thermal conductivity in semiconductor i.e. Germanium. Following sections cover the modeling & simulation, measurements of conductivity, and impact of modelling & simulation. Lastly, related to the current observations, a conclusion has been drawn.

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II. MODELING AND SIMULATION FOR YBCO SUPERCONDUCTOR

Some decade back, computer facility was used as a supplement but now modeling & simulation based on computer has become the most important methodology in many areas of applications [10,11]. System studies are generally conducted with a model of the system. For the purpose of present study, it is necessary to consider maximum details of the system as a model is not a substitute for a real system, but simplifies the system taken into account.

In this approach, we can distinguish between the system, model and simulation appropriately. Like, a system operating in time and space, can be defined as an entity to maintain its existence through the interplay or interaction of its components. A model is a simplified representation of a system to promote understanding of the real system. Further, a model is manipulated through the simulation to enable to compress the time and space [12, 13]. During the interaction many interesting observation can be notices which cannot be perceive without computer simulation when time or/and space were considered separately. Therefore, the present approach enables to accomplish a time and space compression between the interrelationships within a system. Modeling & simulation in estimating the conductivity of YBCO ($YBa_2Cu_3O_7$) superconductors is being discussed in the following two sub-sections.

A. Model for YBCO Superconductor

In the present work, the mathematical model contains one more terms i.e. the interference scattering term $\delta x^3 t^4$ have been introduced[3] which differs from the approach of Ravindran et. A. [14]. Thus, the thermal conductivity model of Callaway's[15] as shown in the equation (1), is given by [3] has been taken for the estimation of thermal conductivity of the $YBa_2Cu_3O_7$ superconductor as follows

$$K = A\, t^3 \int x4\, e^x / [(e^x - 1)^2 .\ F(t, x)]\, dx. \quad \text{------------ (1)}$$

Where F(t,x) is –

$$F(t,x) = [1 + \alpha x^4 t^4 + \beta x^2 t^2 + \gamma t x g(x,y) + (2)\ \delta x^3 t^4 + \in x^2 t^4] \quad \text{--- (2)}$$

In the above equation (2), the parameters A, α, β, γ, δ, and ∈ refer to the scattering strengths due to the boundary scattering, point defect scattering, sheet-like fault, electron–phonon scattering, interference scattering (between point defect and 3-phonon processes) and 3-phonon scattering, respectively. Another term, t (= T/T_c) is the reduced energy, where T_c is the transition temperature of $YBa_2Cu_3O_7$ superconductors. Further, g(x,y) is the BRT function, defined by Bardeen et.al.[16].

B. Simulation for YBCO Superconductor

Research investigation in the field of high temperature superconductors have been carried by several workers due to its peculiar and inherent properties. This has provided a gate through to open the theoretical and experimental investigations for the industrial applications [8]. For high temperature superconductors, transport properties have been reviewed by Teword & Wolkhausan theory[9] and Srinivasan[17]. The simulation technique shows the good impact on the conductivity measurements. In the present analyses, simulation has been carried over the above model in the temperature range from 10K to 240K. During the simulation, the value of interference scattering strength (δ) has been varied and taken as 115, 120 and 125 for the conductivity measurements while other scattering values have been taken as per the Table I. Significant results have been obtained in the form of the simulated responses as shown in the Table II. Further, Fig. 1 depicts graphically the change in the conductivity and also the impact of interference scattering strength (δ).

III.MEASUREMENTS OF CONDUCTIVITY

By taking the values of parameters as shown in the Table I, equation (1) has been simulated in the temperature range from 10K to 240K. Simulated responses has been obtained for three values of the interference scattering strength(δ) taken as 115, 120 and 125. Measurements so obtained have been shown in the Table II.

Table I. Parameters for YBCO Superconductor

Parameters	A	γ	α	β	∈
Values	3.0	20.0	50.0	30.0	0.20

Table II. Conductivity Values for YBCO Superconductor

Temp.(K)	δ=115	δ=120	δ=125
10	1.4121	1.4078	1.4035
20	2.7615	2.7416	2.7220
30	3.4349	3.3981	3.3631
40	3.7495	3.7011	3.6541
50	3.8882	3.8305	3.7747
60	3.9369	3.8725	3.8104
70	3.9347	3.8652	3.7985
80	3.8982	3.8248	3.7543
90	3.8353	3.7587	3.6852
100	3.7516	3.6724	3.5967
110	3.6522	3.5711	3.4938
120	3.5420	3.4598	3.3814
130	3.4255	3.3428	3.2640
140	3.3062	3.2235	3.1449
150	3.1869	3.1048	3.0268
160	3.0697	2.9884	2.9114
170	2.9558	2.8758	2.8000
180	2.8462	2.7676	2.6933
190	2.7414	2.6644	2.5916
200	2.6415	2.5662	2.4951
210	2.5467	2.4731	2.4037
220	2.4569	2.3851	2.3174
230	2.3719	2.3019	2.2359
240	2.2915	2.2232	2.1590

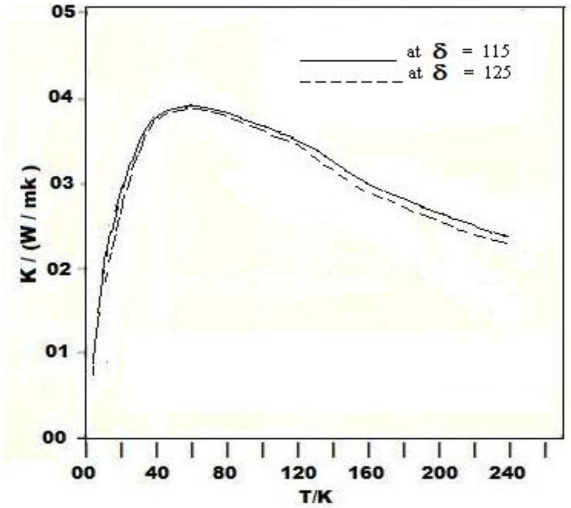

Figure 1 YBCO Conductivity Curve

IV. IMPACT OF MODELING AND SIMULATION

Impact of modeling & simulation has been analyzed by considering the simulated responses in the temperature range from 10K to 240Kfor the three values of interference scattering strength (δ) i.e. 115, 120, and 125. Some interesting results have been noticed. For example, conductivity value increases rapidly up to 40K and becomes approximately stable near the temperature range from 50K to 80K. Afterwards, it slowly decreases. Further, if interference scattering strength (δ) is increased from 115 to 125 as shown in the Table II, then the maximum conductivity comes at 60K and decreases with slight difference of .0644 from3.9369(at δ = 115) to 3.8725(at δ = 120). Similarly, conductivity decreases with slight difference of .0621 from3.8725 (at δ = 120) to 3.8104(at δ = 125). This behavior is clearly projected graphically in the Fig-1.

V. CONCLUSIONS

By considering the proposed modified model, the measurements of the conductivity on three different values of the interference scattering (δ), this controlled simulated approach enables to optimize the measurement process in time and space. In the simulation, the reflection of change in the interference scattering strength (δ) can also be observed as shown in the graphical representation.

REFERENCES

[1] Osetsky, Yu N. Computer-simulation study of high temperature phase stability in iron, Phys. Rev. B-57, No.2 (1998) 755-763.
[2] Naylor, T.H., Chang, Computer simulation experimentation with models of economic systems, John Wiley and sons, New York (1971).
[3] Gairola, R.P., Phys. St. Sol. (b) Vol. 125 (1985) 65.
[4] Choi, Hyo-Sang, Bae, Ok, Kim, Hye-Rim, Park, Kwon-Bae, Switching Properties of a Hybrid Type Superconducting Fault Current Limiter Using YBCO strips, IEEE transaction on applied superconductivity, Vol.14, No.3, (2002) 1833-1837.
[5] Vail, J.M., Emberly, E., Lu, T., Simulation of point defects in high-density lumeinscent crystals : oxygen in barium fluoride, Phys. Rev. B-57, No.2, (1998).
[6] Pavlovic, A.S., Babu, V Suresh, Seehra, S Mohindar, High-temperature thermal expansion of binary alloys of Ni with Cr,Mo and Re : a comparison with molecular dynamics simulation, J. Phys. Cond. Matter 8 (1996) 3139-3144.
[7] Teward, L., Wolkhausan, Th., St. Commun., Vol. 70, (1989) 839.
[8] Srinivasan, R., Studies on High Temperature Superconductors, Anant Narlikar (ed):Superconductors, Nova Science Publisher, NY, Vol.6, (1989) 263.
[9] Bhatt, R.M., Gairola, R.P., Simulation Analysis for Phonon Conductivity of Germanium. In : Chakravarthy, C.R., Patnaik, L.M., Ravi, M.L., Sabapathy, T.,(eds.): Harnessing and Managing Knowledge, CSI Publication (2002) 220-223.
[10] Shanon, R.F., Simulation : A survey with research suggestions, AIIE Transaction 7(3) (1975).
[11] Geoffrey, Gordan, System simulation, Prentice-Hall of India, AIE Transactions, 3, (1975).
[12] Yil maz, Levent et. al., Panel discussion: What makes good research in modeling and simulation: Sustaining the growth and vitality of the M & S discipline, S. J. Mason et. al.(eds): Winter simulation conference, IEEE publication (2008) 677-688.
[13] Law, Avril M.(ed.):Simulation Modeling and Analysis, Tata McGraw Hill, 4th Edition, (2008).
[14] Ravindran, T. R, Sankaranarayana, V., Srinivasan, R. Pramana-J.Physics, Vol. 32, (1992) 109.
[15] Callaway, Joseph, Phys. Rev. Vol. 113 (1959) 1046.
[16] Bardeen, J., Rickayzen, G. Tewordt, L.,Phys. Rev., Vol. 113 (1959) 982.
[17] Srinivasan, R., Studies on High Temperature Superconductors, Anant Narlikar (ed):Superconductors, Nova Science Publisher, NY, Vol.6, (1989) 263.