

40

NO. 36 Page: 33-40

JOURNAL OF SCIENCE, EDUCATION AND TECHNOLOGY

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA.

Vol. 1, No. 2

April, 2008



UMAR PAY SIGS

A Publication of

SCHOOL OF SCIENCE AND SCIENCE EDUCATION

ISSN 1596-9770

Journal of science education and technology
Volume 1 Number 2

April, 2008
ISSN 1596 - 9770

EDITOR

Prof. G. D. Momoh,

Department Of Industrial And Technology Education, Federal University Of Technology,
Minna, Nigeria.

EDITORIAL BOARD

- Prof. K. R. Adeboye (FUT, Minna)
Prof. (Mrs.) H. O. Akanya (FUT, Minna)
Prof. J. A. Gbadyan (Uni Ilorin)
Prof. A. B. Mamman (UDU, Sokoto)
Prof A. A. Oladimeji (FUT, Minna)
Prof. (Mrs.) V. I. Ezenwa (FUT, Minna)
Prof. E. A. Okosun (FUT, Minna)
Prof. S. A. Garba (FUT, Minna)
Prof. B. Okeke (UNN, Nsukka)
Prof. K. A. Salami (FUT, Minna)
Prof. Ampitan (ABU, Zaira)
Prof. M. Galadima

Table of content

Impact of Agrochemicals on Some Selected Rivers in Kontagora Emirate of Niger State A.S., Abubakar and Z., Aliyu	1
A Compendium on Malaria in Tropical Africa J. D. Bala	7
Physical Properties of Bitumen-Stabilized Earth Bricks A. E., Abalaka and W. P., Akanmu	22
Microclimatic Analysis and its Effect on Human Comfort: A Case Study of Minna, Niger State O. Samsideen and T. I. Yahaya	27
✓ Electrical Conductivity and Superionic Transitions in Pure *U., Ahmadu and **N.I. Hariharan	33
Impact of Videotape Instructional Package on Achievement and Retention of Primary Science Concepts among Primary School Pupils in Niger State, Nigeria A. I., Gambari and Z. E., Adamu	41
Determination of Selected Metal Ions in Banana (<i>Musa Cavendishi</i>) and Sugar Cane (<i>Saccharum Officinarium</i>) From Farms Around Ketaren Gwari Dumping Sites *B.E.N. Dauda, Y.B., Paiko, S.O., Salihu and I.O., Isekenegbe.	49
Food, Population And Environmental Degradation In Nigeria A. S., Abubakar and M.M., Bako	53
A Review of Borehole Construction, Development and Maintenance Techniques Around Owerri and its Environs, Southeastern Nigeria. P. I., Olasehinde and A. N., Amadi	57
Analysis of Sorptivity and Void Ratio Measurements of Compacted Subsoil in Bwari-Abuja. U.E., Uno	68
Effect of Selected Preservatives on Tiger Nuts-Milk. A.N., Saidu and F.A., Kolapo	72
Human Capacity Training for Crisis Resolution Among Working Class: Counseling Implications M. K., Abdullahi	76
The Temperature Effect on the Equilibrium Energy Status of Water Held by Porous Media in Gwagwalada -Abuja. U.E., Uno	81
An Assessment of the Geotechnical Properties of the Subsoil of Parts of Federal University of Technology Minna, Gidan Kwano Campus. for Foundation Design and Construction. S. A., Oke and A. N., Amadi	87
Climate Change And Health: An Appraisal on Implications for Research, Monitoring and Policy. S. A., Oke and A. N., Amadi M. K., Abdullahi	105
Design, Construction and Characterization of Metal Detector Device J. A., Ezenwora,	110
Effect of Climate Change on Poultry at Abu-Turab Minna P. S., Akinyeye	121

The Challenges of HIV/Aids and
C., Nsofor 18

Effect of Compographies Instructions on
Primary Pupils in Niger State, Nigeria. * A.
and M.I. Abdulahi 19

Mitigating the Effects of Climate Change in Ser-
Antibiotic Resistance Pattern of Bacteria Isolated from Ci-
Niger State J. A. Kuta and O. Olumide 20

Impact of Trace Metals Discharged from Tannery Industries on
Northern Nigeria ¹J., Yisa; ²E. B., Aghaji and ³E. M., Okonkwo 21

Leadership Ingenuity, An Imperative for Entrepreneurial Development M.M. 22

Assessment of Groundwater Potential of Parts of Owerri, Southeastern Nigeria A. Nathaniel 23

The Impact of Educational Technology in Teacher Education A. Nathaniel 24

Aspect of Limnological Study of River Chanchaga and Potabe Water in Minna Environs,
Niger State, Nigeria R.O Ojufiku, and R.J. Kolo. 25

Investigation of Optical Properties of Cds Thin Film Deposited by Successive Ionic Layer
Adsorption and Reaction (Silar) K. U Isah. 26

Chemotherapeutic Treatment of Diabetes Mellitus (A. Review) Saidu, A.N 27

1554 April 2008
1556 1556-5770

..... Learning of History in Some Selected Area of A. Zubairi	188
..... Legislations on Fisheries Conservation A. Cass Area P. S. Gana and I. Yaro	194
..... Modeling of the Precambrian Rocks of Mahambashi Area of Using Aeromagnetic P. S. Akinoye	199
..... Rainstorm Producing Factors and Root Crops (Yam and in Minna and Its Environs) P. S. Akinoye	204
..... Theory of Pavlov: Implication for Human Capacity Building I. E. Kuta	217
..... Perception of Students About Online Registration S. A. Adepaju and J. K. Alhassan	221
..... Antibacterial Activity of <i>Ocimum Gratissimum</i> Leaf Extracts on Some Selected Bacteria	226
..... Numerical weather prediction A mathematical model for Rainfall Estimation in Niger state via satellite. A M Adamu	239
..... Towards an effective Public Relations in Nigerian Secondary Schools - A Historical Perspective C. U. Nkokelonye	245
..... On Variances when Data Arise From Two-Stage Sampling with Replacement I. A. Nabu	250
..... Effects of Spacing and Variety on the Yield (Sorghum) A. F. Busari	261
..... Learning theory of pavlov: Implication for human capacity building. I. E. Kuta	261
..... Relationship between Technical Student Choice of Trades and Career Aspirations G. A. Usman and I. Drisu	265

ELECTRICAL CONDUCTIVITY AND SUPERIONIC TRANSITIONS IN PURE SILVER AND LITHIUM SULPHATES

* U., Ahmadu and **N.I., Hariharan

*Department of Physics, Federal University of Technology, Minna,
**Department of Physics, Ahmadu Bello University, Zaria.

Corresponding author: +234066034370; e-mail: u.ahmadu@yahoo.com

Abstract

Pure samples of polycrystalline Silver and Lithium sulphates (Ag_2SO_4 and $Li_2SO_4 \cdot H_2O$) were heated to a temperature of about 600°C from 27°C. The transition temperatures for Superionic conduction was determined together with the activation energies for the conduction as 290°C, 0.35eV and 260°C and 0.57eV respectively, for lithium and silver ions. Similarly, the character of the changes in resistance has been described. The silver and lithium sulphates samples were subjected to several heating runs and the same parameters were determined. Superionic transition was observed in the silver sulphate sample but not in the lithium sulphate. It was observed that thermal cycles reduced the sample resistance.

Keywords: Doping; Lithium Sulphate; Silver Sulphate; Superionic conductor.

Introduction

Current trends in research have been geared towards the search for compact energy sources in the solid state, i.e. Solid state electrolytes or superionic conductors (Yamazoe and Miura, 1995). Solid state energy sources have many advantages over liquid electrolytes in terms of compactness, versatility and mobility. They are used for rechargeable batteries and also as electrolytes in fuel cells (Cuenca, 2002; Onuma and Kaimai et al, 1998). These rechargeable batteries are found in microbatteries, sensors and smart windows (Balkanski, 1990; Miura and Ono et al, 1998; Narita and Can et al, 1995; Worrel, 1998) and in mobile phones, laptop computers, among others. Lithium compounds are commonly used in lithium ion batteries. Their conductive properties are principally derived from ions rather than electrons and this is normally achieved at high temperatures during which superionic transition is said to set in.

The current lithium-based compounds have a lot of problems (Weller, 2000), current research is therefore geared towards developing materials that are cheaper, stable, environmentally friendly, have high charge capacity/density and in particular, high conductivity at room or ambient

temperatures (Hull and Keen, 2003), temperature at which most appliances operate. The most widely used materials are $LiCoO_2$ and $LiMnO_2$. The former has been associated with one or more of the above desirable parameters. There is the need to improve the electrical properties of these compounds, such as their electrical conductivity and mobility. Hence the research in silver and lithium sulphates are important because of the good electrical conductivity and polarisability of silver on the one hand, and the small size of lithium ion and its light weight, which make it easily diffuse and contribute to electrical conductivity.

The lattice structure of silver sulphate is orthorhombic whereas lithium sulphate is monoclinic. Silver sulphate is a better conductor than lithium, however, its cost puts it at disadvantage. Several research have been carried out on these compounds (Tetrycz and Kozłowski, 1998; Tetrycz and Nitsch, 2000), for example, using thick-film technology in gas sensors for environmental pollution detection.

In the present study, report is presented on samples of silver and lithium sulphates, in Pelletized powder forms. The objective is to determine the superionic transition temperatures, the activation energies and electrical conductance of

compounds and compare them, including the effect of repeated heating runs on these parameters. This is believed will facilitate further study of these compounds to enhance their conductivity by forming solid solutions of the compounds.

The Arrhenius plot ($\ln GT$ vs. $1/T$) was used to analyze the results. The conductivity is related to temperature by: $\sigma = \sigma_0 / T \exp(-E_a/T)$, where σ_0 is the pre-exponential factor, E_a is the activation energy for conduction and T is the absolute temperature. However, the conductance has been used instead of the conductivity, σ .

(APLAB, India, 1200°C maximum); digital Multimeter (Gold Model, WG022) and Copper/Constantan thermocouple were used for the measurements. Acetone and deionised water were the cleaning agents. Current and voltages were measured three times, from which the resistance (and average resistance) was calculated, from room temperature to about 600°C, for each temperature. The conductance (G) was calculated from the computed values of the average resistance. A plot of $\ln GT$ Vs $1/T$ (Arrhenius plot) was obtained from which the activation energy, E_a was deduced from the slope of the graph.

Results and Discussions

The materials investigated revealed high ionic conductivity at elevated temperatures. In particular, silver sulphate. It has been generally difficult to obtain stable lithium sulphate at these temperatures (7-820°C) due to cracking or the samples at these temperatures. Fig. 1 shows a low conductivity of a that evolved

silver and
typical

... observed owing to sample
... lity beyond 290°C.

However, the Arrhenius plot of
sulphate, room temperature to
, showed superionic transition with
activation energy at transition temperature
0.32eV comparable to that reported
(Tetrycz and Nitsch, 2000), while being
(activation energies) 0.83eV and 0.57eV at
room temperature respectively, for the
reported (Tetrycz and Nitsch, 2000) and
work. Correspondingly, room
temperature resistance fell from 1.71KΩ to
4Ω at maximum temperature.

Superionic transition was observed
occur at 260 °C compared to 420 °C
(Tetrycz and Nitsch, 2000). Fig. 2 shows
the plot from which it can be inferred that
the transition temperature is not well
defined as factors such as preparative,
thermal history; composition and
crystallinity may affect the transition
temperature (Sunandana and Kumar,
2004). Thus the low activation energy may

The second thermal
(580°C) has average resistance
temperature of 33KΩ.
activation energies were
in these regions and
temperature was 350°C
cycle (C3)(27-490°C
resistances as 122Ω
corresponding acti
0.07eV and 1.32
temperature of
suggest a system
the sample was
particular the
lower temper
beyond the
character
pointing to
the heati
Also it
temper
to the
and
heat
tra

able up to 640°C. This may be due to irregular features, attributed to the very high resistance of lithium at room temperature, and to the nature of the sample, its inhomogeneity and polarization. However, the second sample could be subjected to another heating cycle (C1)

to 640°C, where resistance reduced to 1.4Ω, from 11.00MΩ at room temperature. The activation energy was found to be 0.59eV throughout the regions with no sharp transitions observed, fig.4. A second thermal cycle (C2) reduced the

resistance to 1.4Ω at the maximum temperature of 600°C. The form of the graph is essentially the same as C1 with activation energy almost uniform at 0.69eV. It must be remarked that most researchers have not focused on the systematic study of thermal cycles of superionic conductors, this is emphasized here, fig.5. Up to 500°C was reached for the third cycle (C3) of silver sulphate in which the resistance was 1.4Ω at room temperature, the activation energies were 0.021eV and 1.2eV at the lower and high temperature regions respectively, fig.6.

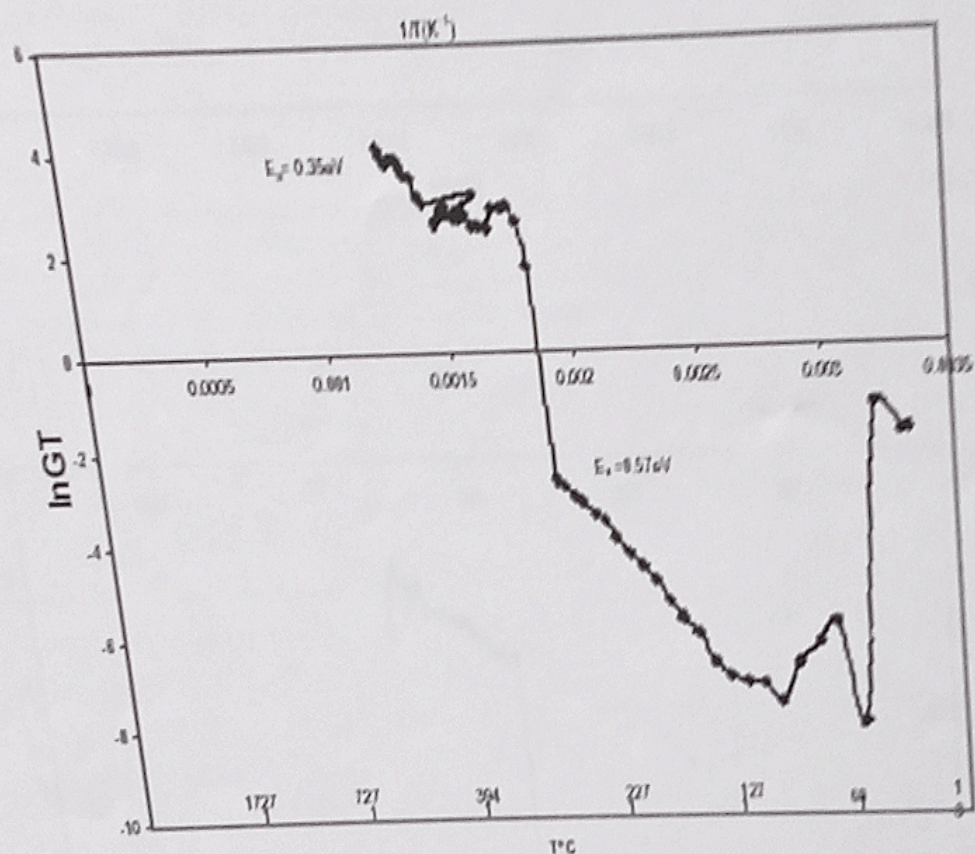
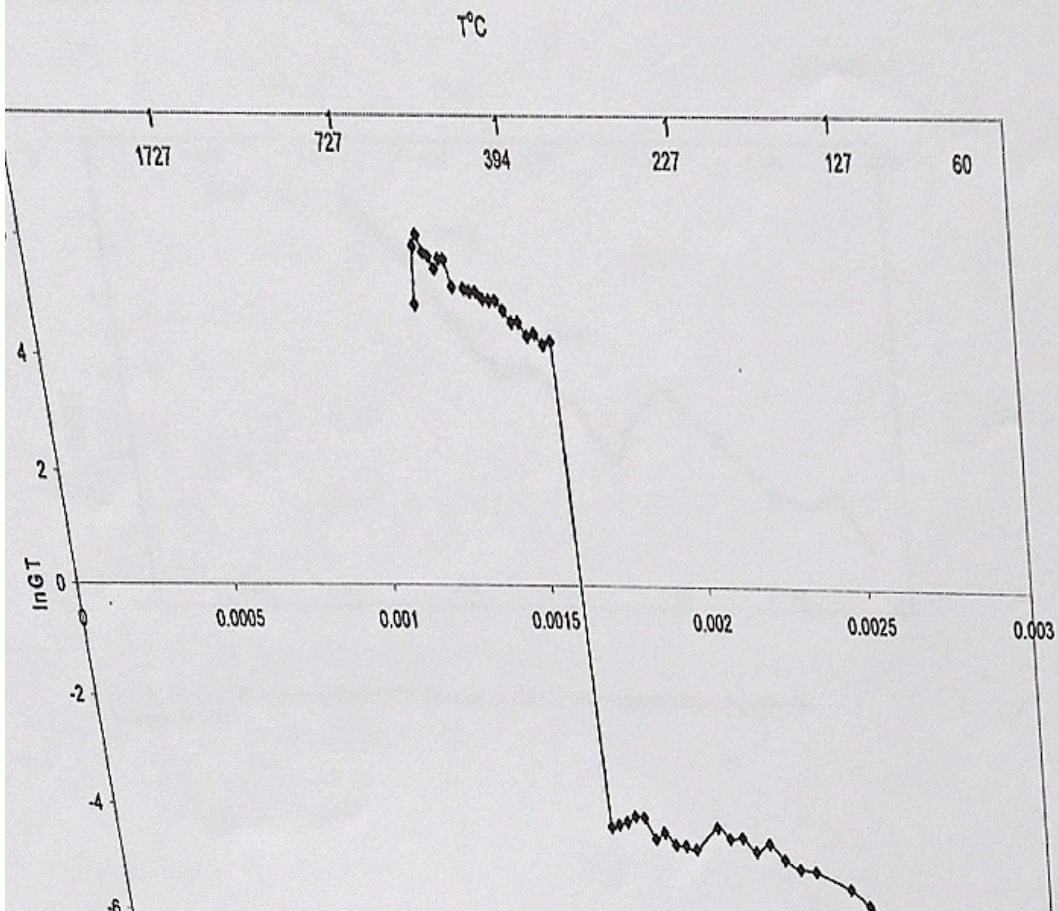
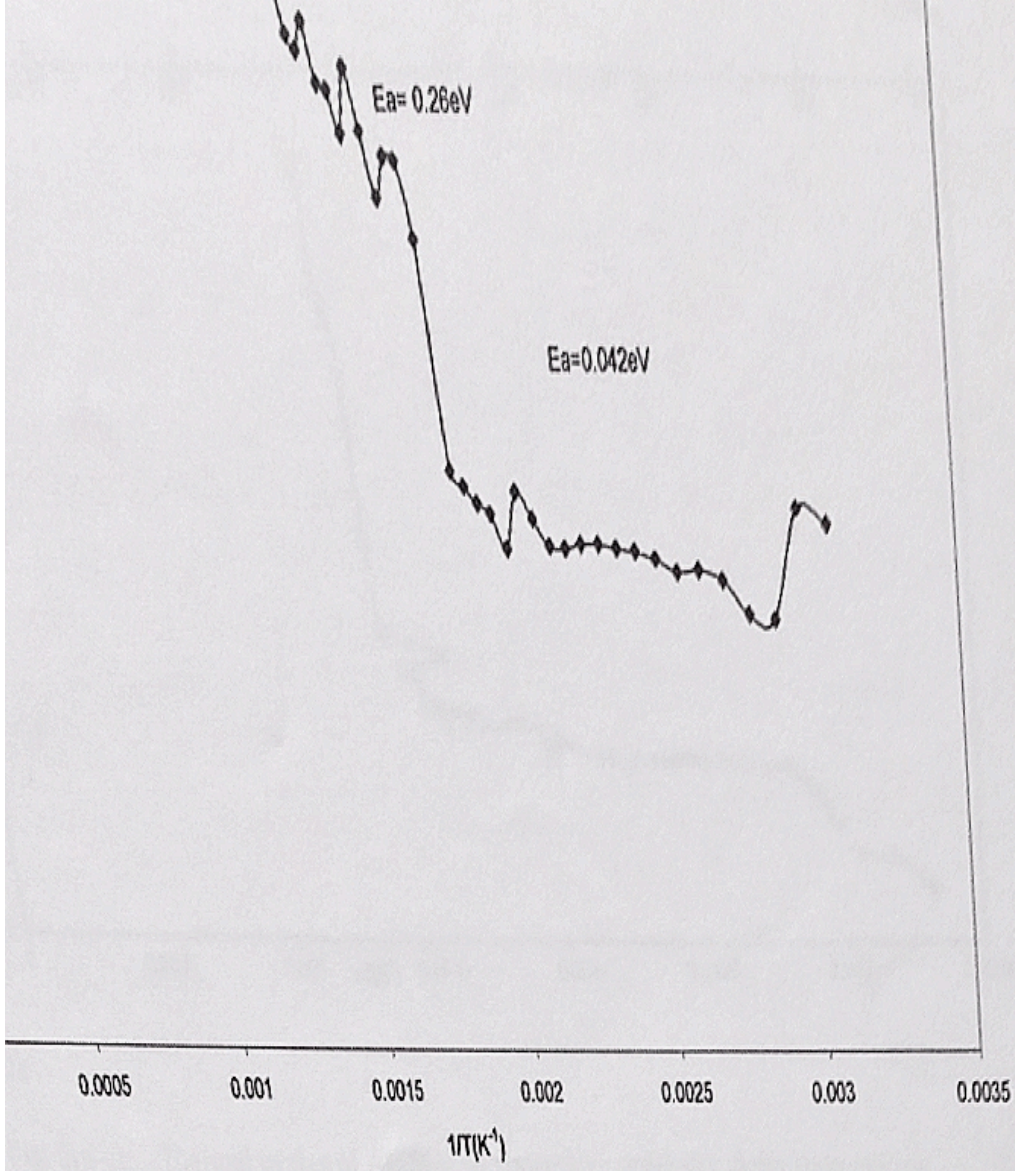
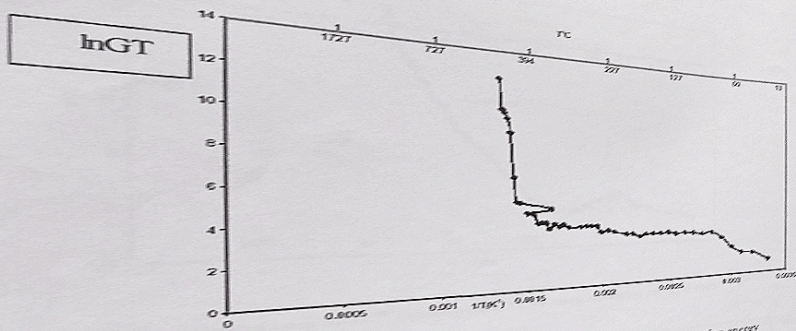


Fig.2: Arrhenius plot of pure Silver Sulphate showing activation energies 0.57eV and 0.35eV at lower and higher temperature respectively. The transition temperature is 260°C.





(c)
 Fig. 3(a-c): Thermal cycles of Ag_2SO_4 in successive order (a): Activation energy $E_a = 0.042eV$ at lower temperature. The transition temperature is $350^{\circ}C$; (b): $E_a = 0.21eV$ at lower temperature and $0.3eV$ at temperatures transition is $350^{\circ}C$ and (c): $0.07eV$ at lower temperatures; transition temperature is $350^{\circ}C$.

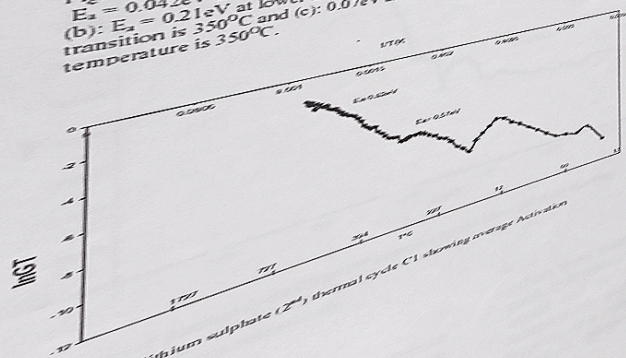
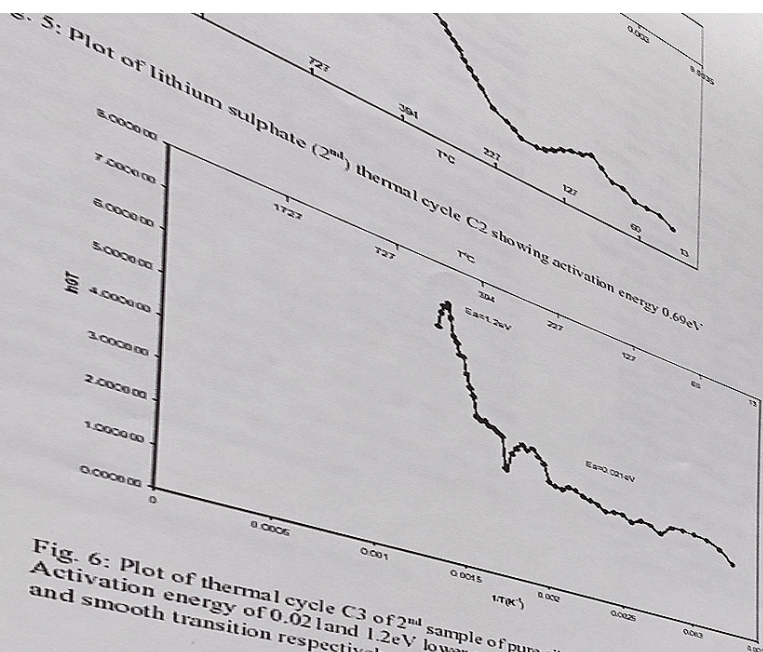


Fig. 4. Plot of lithium sulphate (Zn) thermal cycle C1 showing average Activation energy, $0.59eV$.



Conclusion

All the samples of lithium sulphate exhibited increase conduction with temperature, and reduced activation energies in the lower temperature regions in the thermal cycles. Though some samples were highly unstable and cracked,

others were stable, yet behaved irregularly, such that transition to the superionic state could not be observed, given the high temperature required. Polarization and the hygroscopic nature of the sample was a problem, particularly, in humid weather

a.c. conductivity measurements could reduce this problem.

Samples of pure sulphate however, were generally more stable and had better cohesion. Thus it was relatively possible to reach higher temperatures. The pure and some of the thermally cycled samples have Arrhenius character, though some of the samples showed poor stability too. Transition temperature for one of the pure samples was 260°C, whereas the thermally cycled ones were 250, 350 and 400°C, for the three cycles obtained for the first sample.

The research established that silver sulphate is good superionic conductor and that repeated heating of samples does not necessarily reduce the transition temperature, even though the resistance reduced. Also, lithium sulphate, though highly resistive at ambient temperatures, reduced in resistance with increasing thermal cycles. The thermal cycles do not show a marked transition, rather, generally a gradual build up in conduction was observed. It is proposed that since silver sulphate is better conductor, when solid solutions of the two are formed, by doping one with the other, it may bring about enhanced conduction, even at room temperatures, which still remains the big challenge. This is the line of research the authors intend to investigate.

References

Balkanski, M (1990). *Physics World*, 29.

- April 2008
ISSN 1596-9770
- Corish, J., Jacobs, J.W.M., Radhakrishna, S. (1977) in: *Surface and Defect Properties of Solids*, Vol.6, The Chemical Society, Burlington House London, pp218-227.
- Cuenca, M.M.G. (2002). *Novel Anode Materials for Solid Oxide Fuel Cells*: Ph.D Thesis, University of Twente.
- Hull, S. and Keen, D. (2003). Rutherford Appleton Laboratory, EPSRC Grant GR/M38711.
- Lockwood, D.J. and Choi, B. (1989). *Physical Review B* 40(7).
- Miura, N., Ono, M., Shimano, K., Yamazoe, N. (1998), *Sensors and Actuators B* 49 101-109.
- Narita, H., Kanazawa, Y., Mizusaki, K., Tagawa, H. (1995), *Solid State Ionics*, 79, 349-353.
- Onuma, S., Kaimai, A., Kawamura, K., Nigara, Y., Kawada, T., Mizusaki, J., Inaba, H. and Sunandana, C.S. and Kumar, P.S. (2004). *Bulletin of Material Science*, 27(1): 1-17.
- Tagawa, H. (1998). *Journal of Electrochemical Society*, 145, 920 - 925.
- Teterycz, H., Kozłowski, J. (1998). *Proc. COE 98* Jurata, May, pp173-177.
- Teterycz, H., Nitsch, K. (2000), *Proc. IMAPS* Poland, September.
- Vitio, I. (1999). *Synthesis, Structure, Conductivity and Electrode Properties of some Double Diphosphates, Silicates and Lithium Manganese oxides*, PhD Proposal, Institute of Solid State Physics, University of Latvia, Riga, Latvia.
- Weller, M.T. (2000). *ISIS Experimental Report*, Rutherford Appleton Laboratory, U.K. RB No.11987.
- Worrel, W. (1998). *Chemical Sensor Technology*, Vol.1.
- Yamazoe, N., Miura, N. (1995), *IEEE Transactions on Components, Packaging and Manufacturing Technology*, Part A, 18(2)