STUDIES ON ANTIMONYSELENIDE NANOSTRUCTURES

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Nanostructured Antymonyselenide were synthesized by a simple solution chemical approach and electrical properties of that were investigated in details.

Important properties of Sb_2Se_3

- *It's a P-type semiconductor (band gap ~ 1.2ev)*
- *Exhibits electrical and electro-optical switching property*
- *Exhibits good photovoltaic properties*
- *It's a good thermoelectric materials*

Applications of Sb_2Se_3

- **Optical recording system**
- **Insulating materials in MIS solar cells**
- **Thermoelectrical cooling devices**

Scheme of Synthesis

Se^{2-} ion source + Sb^{3+} ion source → Product

Aqueous ammoniacal medium

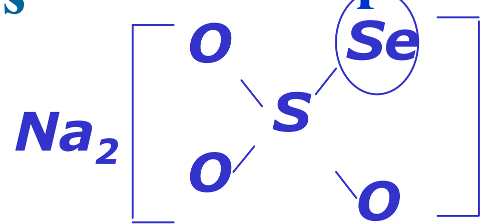
Sodium selenosulphate

Potassium antimony oxide tartrate

Antimony selenide nanocrystals

Preparation of sodium selenosulphate

4.83 gm sodium sulphite in 100ml water + 2 gm selenium → (Refluxed for 10 hours) Sodium selenosulphate



Synthesis of Sb_2Se_3 nanocrystals

0·12 gm potassium antimony oxide tartrate in 15 ml Millipore water

0·12 gm sorbitol in 15ml Millipore water

Well stirred with NH_4OH
pH=10.8

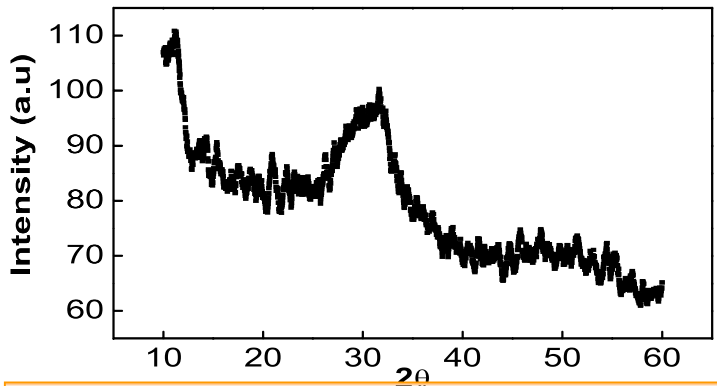
2 ml sodium selenosulphate

Brown

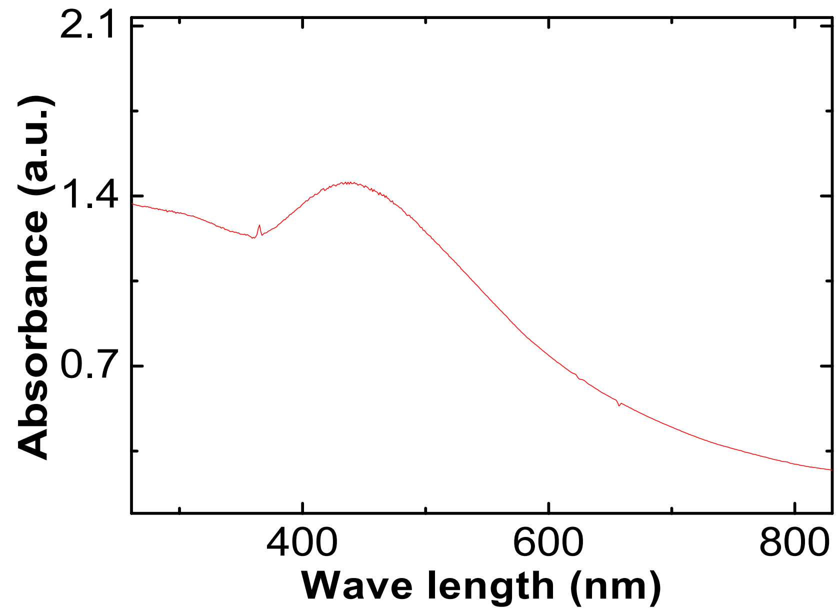
Dark brown

Sb_2Se_3 Nanocrystals

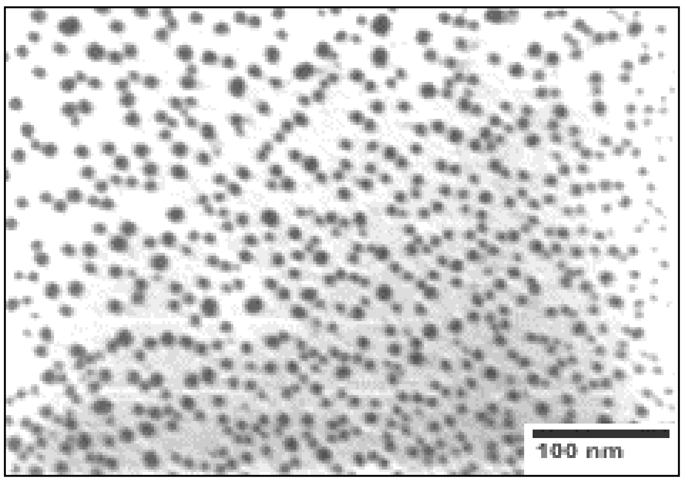
CHARECTERIZATION



XRD spectra shows a broad hump at 2θ=31.2,JCPS data sheet suport that maximum intensity at 31.2 for 221 plane



UV-vis absorption spectrum of an aqueous solution of Sb_2Se_3 depicts a peak at 437nm corresponding to excitonic energy gap of 2.84 eV

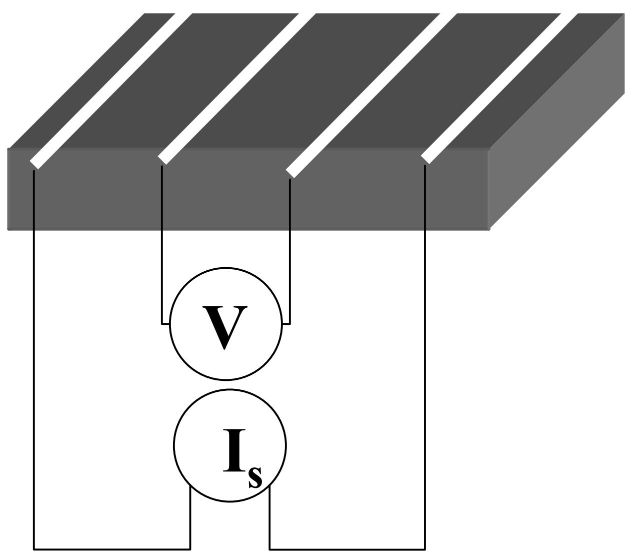


TEM micrograph depicts dispersed spherical particles of average size 16 nm

Electrical characterizations

For electrical characterization a pellet was made by cool pressing the powder samples at 5 ton pressure for 5 minute. A rectangular block was cut from that pellet of dimension 1cm X 0.4cm

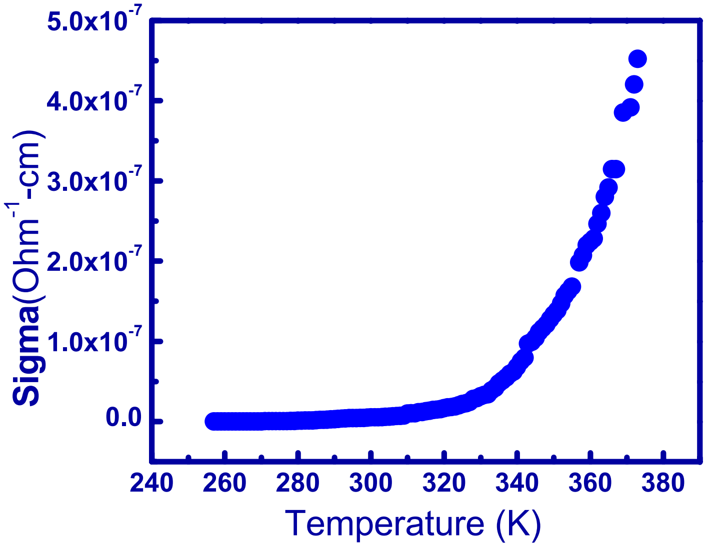
Conductivity measurement



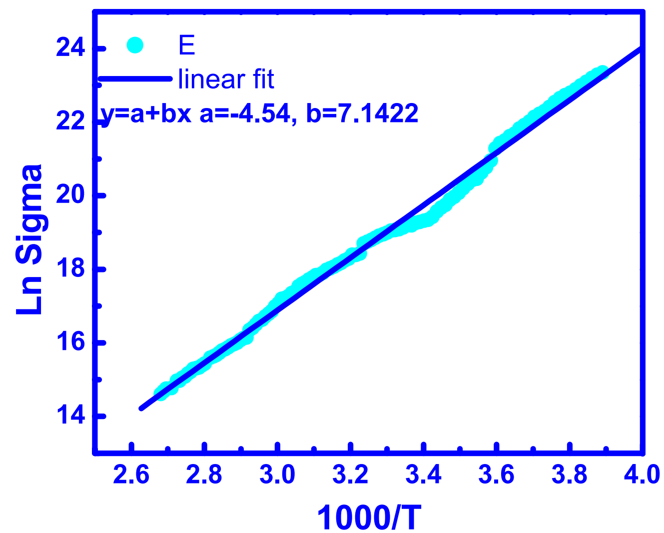
I_s from a keithly programmable current source

V measured by a keithly 617 multimeter

Variation of DC conductivity with temperature



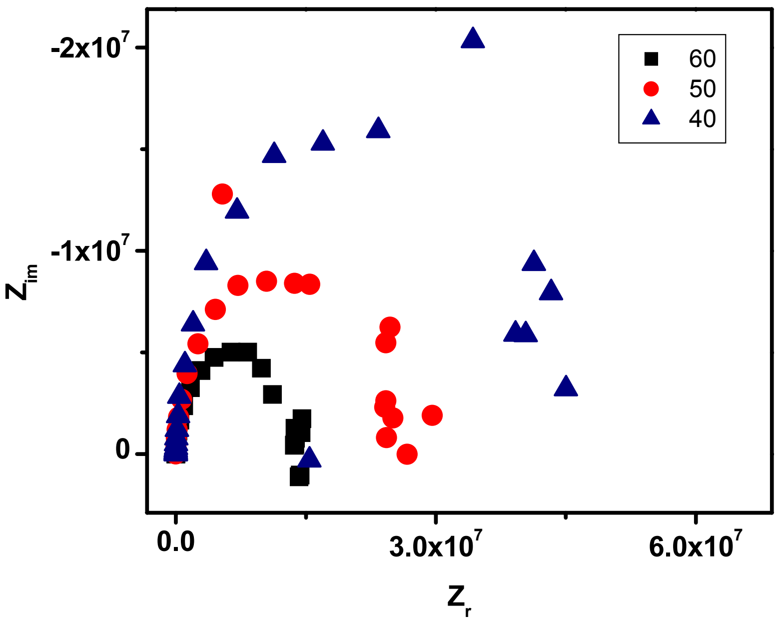
Variation of conductivity with temperature.



Logarithmic variation of conductivity with inverse of temperature

- DC conductivity variation with temperature shows a arhenious type of conduction.
- Liner fit of logarithm of conductivity with temperature inverse gives activation energy as .616ev

Cole-Cole plot at different temperature



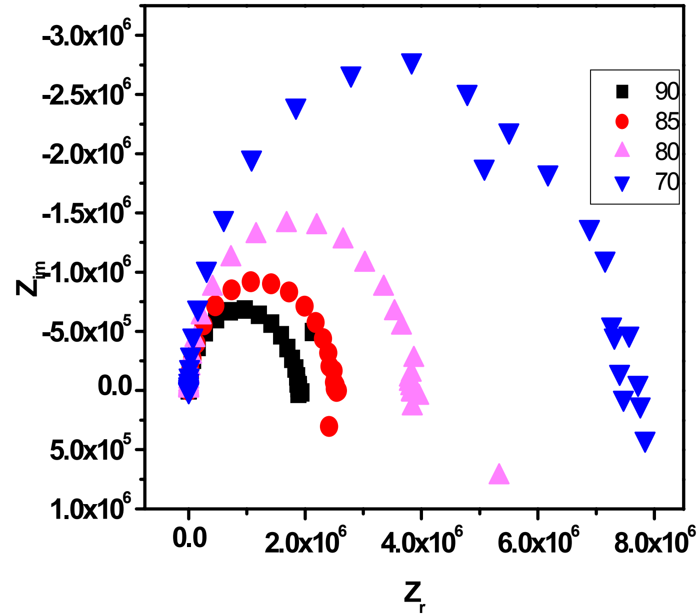
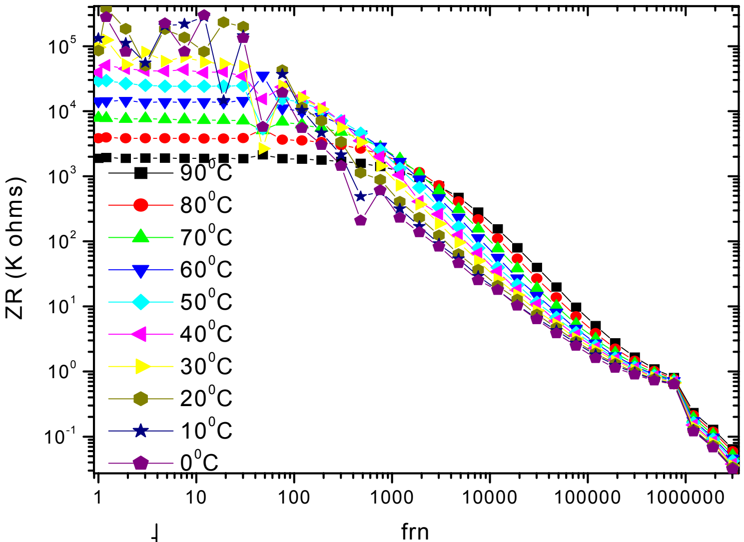
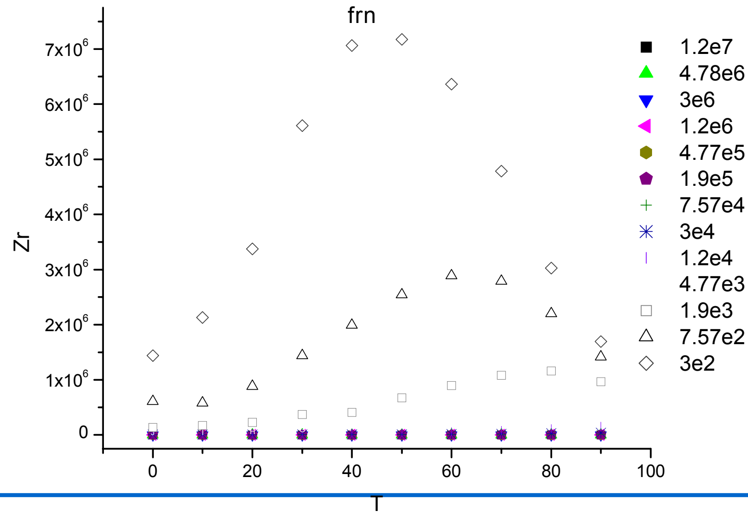
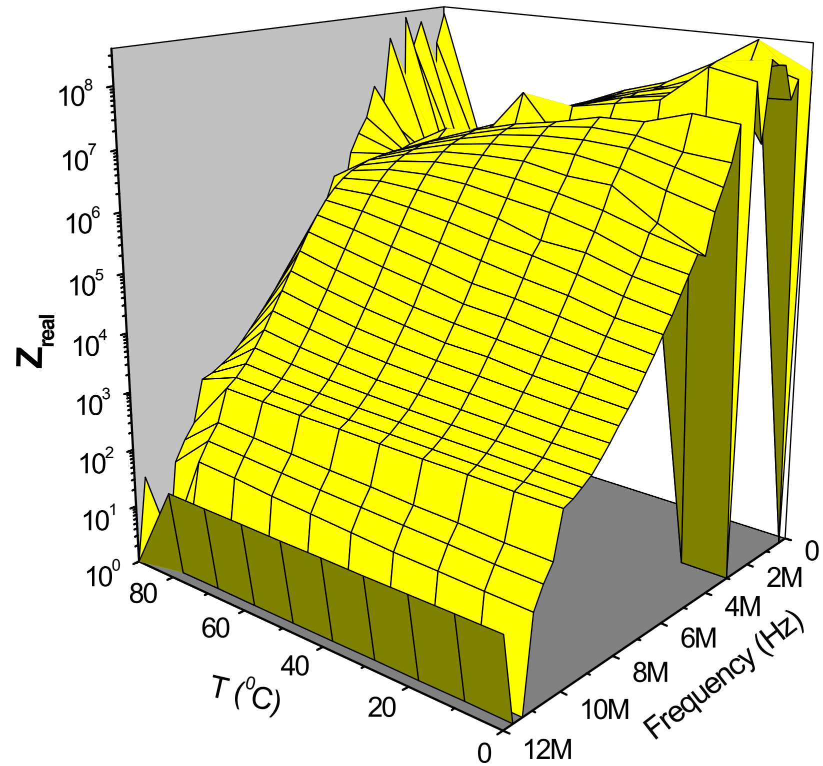


Figure represents the complex impedances plot for different temperature range. Each point corresponds to a different frequency. The plot shows increasingly resolved semicircles with increasing temperatures.

Variation of real part of impedance with frequency and temperature

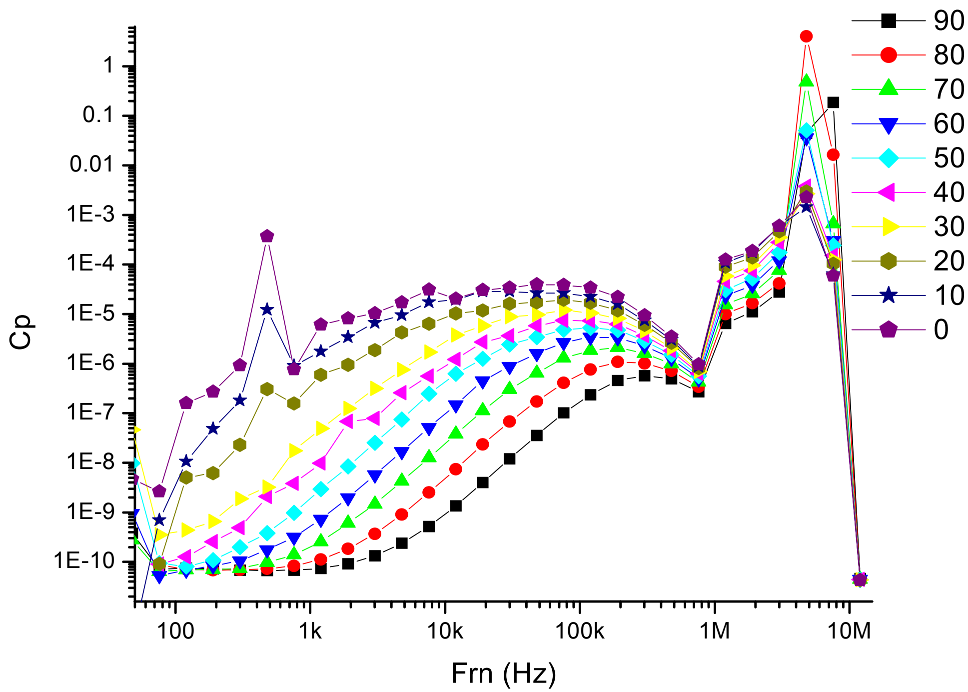


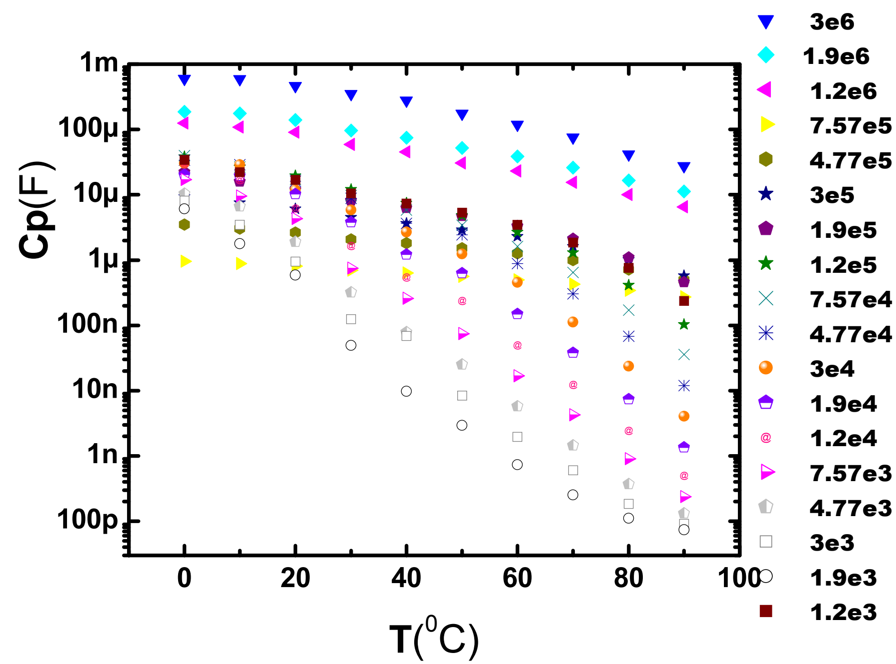




Impedance is sensitive to temperature in low frequency range and gradually become independent in high frequency range

Variation of real part of capacitance with frequency and temperature





In low temperature range value of C is nearly constant and it decreases with increase of temperature. However the rate of change of capacitance (dC/dT) is higher for lower frequencies and increases with increase in temperature.

Conclusion

- Nearly monodispersed antimony selenide nanocrystals can be synthesised in simple solution phase approach
- The optical energy gap increases in nanophase from 1.2 eV for bulk to 2.84eV
- The value of DC conductivity decreases for nanophase but the value of activation energy increases
- The AC conductivity initially decreases with increase of temperature but after a transition point (frequency dependent) it increases with increase of temperature.