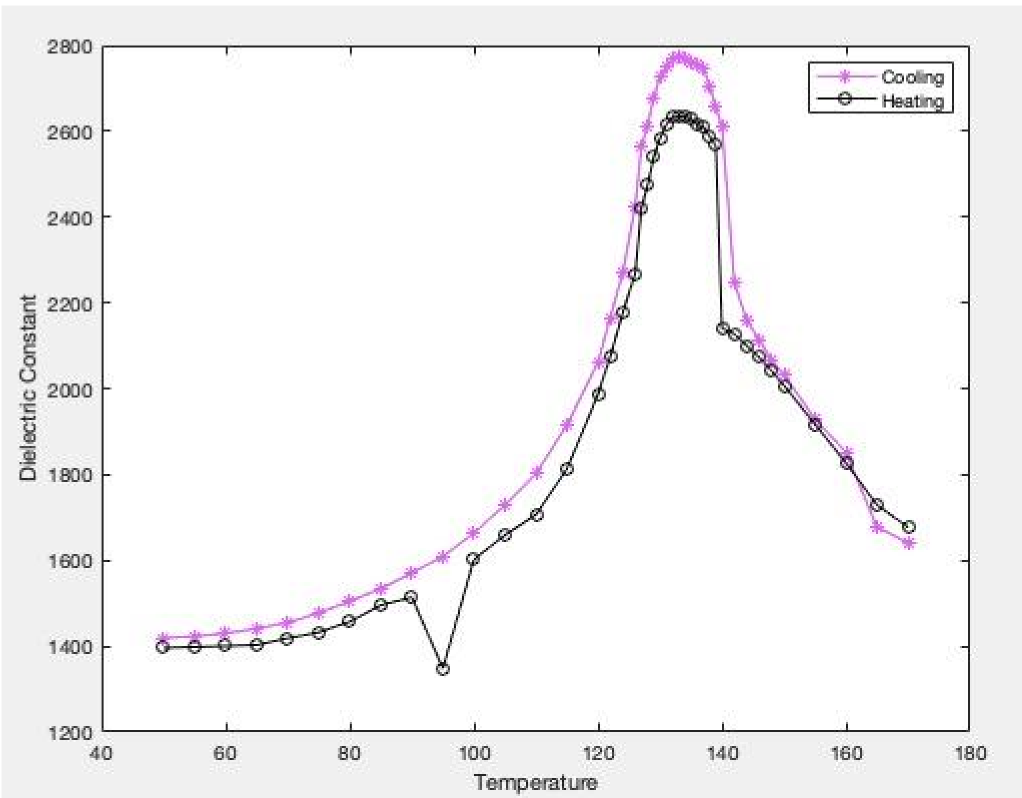
ESO205 Lab-5

SHUBHAM GUPTA 180749 **SEC-3, GROUP-3**

Part 1:
Plot the dielectric constant of barium titanate ($BaTiO_3$) as a function of temperature during heating and cooling to determine the Curie temperature related to the ferromagnetic to paramagnetic transition.



During heating, the required transition occurs at 134℃ and during cooling, the needed transition occurs at 133℃.

The Curie temperature for the above experiment comes out to be $\frac{134 + 135}{2}$ = 133.5℃

Part 2:

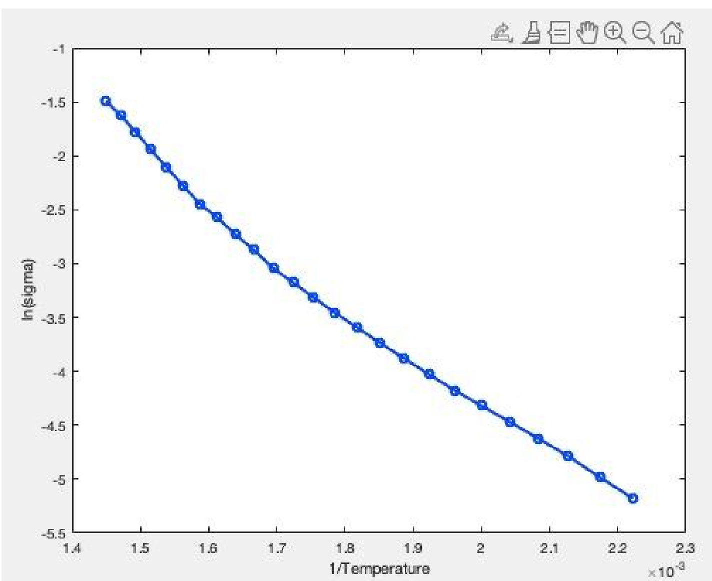
Determine the vacancy formation energy based on ionic conductivity data as a function of temperature for NaCl. Also, plot the resistivity of doped zirconia as a function of temperature and explain the reasons for the difference in variation of resistivity/conductivity of doped zirconia vis a vis NaCl.

σ(conductivity) = $A \cdot \exp\left(\frac{-E_m + \frac{\phi}{2}}{k \cdot T}\right)$

where,
A = a constant for a particular crystal
E_m= Activation energy of vacancies pair
ϕ = formation energy of such pairs

Taking natural log

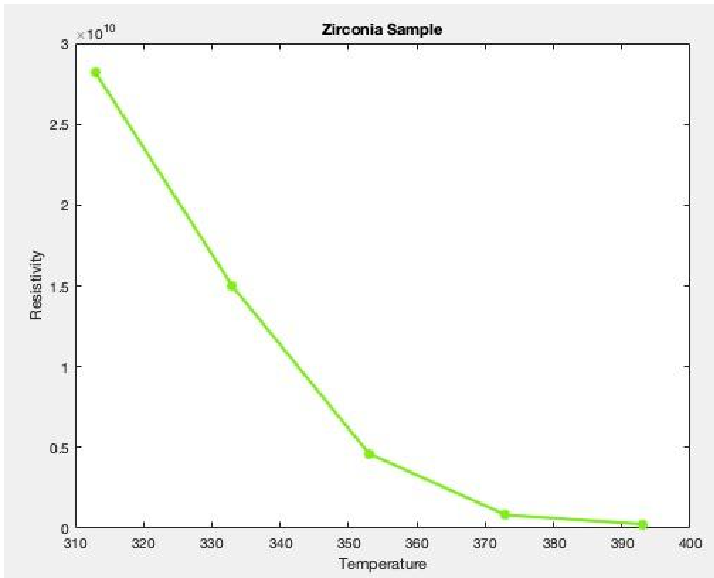
$ln(\sigma) = ln(A) + \left(\frac{-E_m + \frac{\phi}{2}}{k \cdot T}\right)$



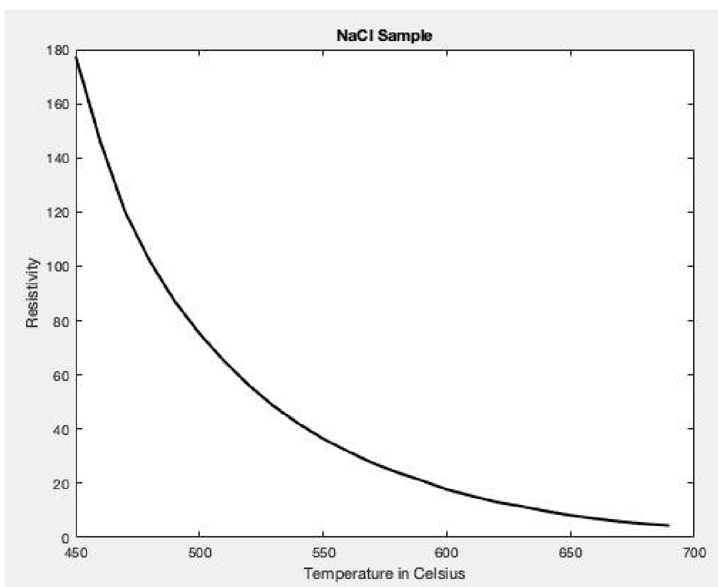
Slope of the curve(m) ~ -10.3×10^3
Hence, Vacancy formation energy = m × k(Boltzmann constant)
$= -10.3 \times 10^3 \times 8.617 \times 10^{-5}$
$= -0.89$ eV

Assuming ϕ = 2.13eV
E_m = 1.94eV

The plot of Resistivity vs temperature of doped Zirconia :



The plot of Resistivity vs Temperature of NaCl :



Reasons for the difference in variation of resistivity/conductivity of doped zirconia and NaCl:

As the temperature increases, the conductivity of NaCl increases due to changes in ion mobility and an increase in the number of defects.

For zirconia, the electrical conductivity is only the result of ion mobility, which leads to differences in electrical conductivity.