A STUDY OF MAGNETIC SUSCEPTIBILITY OF SOME Cu(II)COMPLEXES

Thesis

Submitted to the Faculty of Science Cairo University in Partial Fulfilment of the requirements of the M.Sc. Degree in solid state Physics

By

Samia Soliman Arafat

1990

SUMMARY

Magnetic susceptibility as function of temperature between 78K and about 400K has been measured at different magnetic field strength for the three compounds (DL-alaninium)$_2$CuCl$_4$, (para-chloroanilinium)$_2$CuCl$_4$ and (para-Toluidinium)$_2$CuCl$_4$. The infrared and visible spectra as well as the X-ray diffraction of the three powdered samples were obtained.

For the (DL-alaninium)$_2$CuCl$_4$ compound a thermochromic transition at T_{thermo} = 280±2K was obtained, whereby the compound undergoes structural phase transition to high temperature phase which has a tetragonal unit cell with lattice constants a = b= 5.56A^o and c =16.65A^o with a space group $I\bar{4}$ denoted as high temperature phase(I). The low temperature phase II (the green phase) shows magnetic interactions decribed by the Bower-Bleany equation, Which reveals that the system is made up of copper dimers with a triplet ground state and a thermally accessible singlet state. The interadimer interaction was found to be J/k = +70K. At very low temperatures antiferrmagnetic interdimer interaction takes place.

For the (para-chloroanilinium)$_2$CuCl$_4$ the compound undergoes two phase transitions both of them are thermochromic at T_{thermo} = (290±2)K and T_{thermo} = (214±4)K. This is summarized by the equation

phase III $\xrightarrow{T_{thermo} = 214K}$ phase II $\xrightarrow{T_{thermo} = 290K}$ phase I

In phase I the compound contains Cu_2Cl_6 dimers(orange color), Phase II contains tetragonally distorted octahedral $CuCl_6$ (yellow) and in phase III the copper exists as tetrahedrally coordinated $CuCl_4^{2-}$. In phase III short range magnetic ordering sets in at about 200K. Using mean field theory results in an exchange interaction of (J/k) = 22.5±2.5.

As for the (para-Toluidine)$_2CuCl_4$ compound only one phase transition has been observed at T_{thrmo} = 303K. Thermal hystrises has been observed reflecting first order phase transition at that temperature. The low temperature phase does not show an indication of structural change at low temperature. Short range magnetic interaction sets in at about 200K . High temperatures series expansion for quadratic Heisenberg ferromagnetic interaction gives an excellent fit to the data yielding (J/K)=+19K .

The value of the exchange interaction obtained for (para-chloroanilinium)$_2CuCl_4$ and (para-Toluidinium)$_2CuCl_4$ are in very good agreement with each other and with other compounds of similar structure.

The lattice constant for the (para-Toluidinium)$_2CuCl_4$ has been calculated and was found to be a = 6.90A^o, b = 7.05A^o, and c = 33.13A^o.

The diamagnetic susceptibility of (P-Toluidinium)$_2ZnCl_4$ has been measured at different temperatures and was used for diamagnetic correction.

Comparison of the structural phase transition of the three compounds points to the fact that the motion of the organic group linking the copper chloride layers is the

trigerring factor in these transitions. The motion of the organic group is responsible for the different N-H...Cl hydrogen bonding schemes that are found in the three compounds. As a secondary effect it is able to change the tilting of the copper chloride octahedra.