

A STUDY OF METALLIC COLLOIDAL PARTICLES  
IN ALKALI HALIDE CRYSTALS

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## PREFACE

Several physical properties (like magnetic, optical, absorption and scattering etc) exhibited by metallic colloidal particles are remarkably different from those of bulk materials. Many authors have investigated colloids as suspensions in various liquids but the colloids in crystalline matrices have the advantage that the metal and the insulator have an intimate contact with each other with the interface uncontaminated by any gaseous layers so that transport properties like electrical and photoconductivity etc can be studied. Though some investigations have been made on the properties of colloids in crystals, our understanding of these systems is still not complete. In this thesis the author reports the results obtained on the investigation of potassium and silver colloidal particles in alkali halide crystals. The physical properties studied include optical absorption, electron spin resonance and photoconductivity.

The thesis is divided into six chapters and four appendices. A survey of earlier work on metallic colloidal particles in alkali halide crystals is given in Chapter I along with a general introduction to the present investigations. The experimental techniques used are discussed in Chapter II.

The shape and size distribution of silver colloidal particles in various samples were studied by electron microscopy and are given in Chapter III. The distribution functions which approximate the actual size distribution of the particles are also discussed.

Colloidal metal particles exhibit optical absorption which is characteristic of the metal and the surrounding medium. Besides these, the size of the particles and the size distribution, if all the particles are not of the same size, also play an important role in determining the shape of the absorption spectrum. A detailed analysis of this dependence has been made and the results for silver colloids in KCl crystals are discussed in Chapter IV. Results of conduction electron spin resonance studies on silver colloidal particles in KCl crystals are discussed in Chapter V. Chapter VI deals with photoconductivity of the potassium colloidal particles in KBr crystals.

Appendix A discusses the application of optical absorption band to evaluate the size distribution of potassium colloidal particles in KCl crystals. Appendix B describes the method of calculation of concentration of the metal in the crystal. Explicit expressions for electric and magnetic multipoles in Mie theory are given in Appendix C. Appendix D describes the complete computer programs for calculating the parameters of the size distribution function and generating theoretical absorption curve.

Some of the work reported in this thesis has been published in the following papers.

1. 'Photoconductivity of Potassium Colloids in KBr Crystals', J. Phys. Soc. Japan 36, 769 (1974).
2. 'Electron Microscope Studies of Silver Colloids in KCl Crystals', J. Appl. Phys. 45, 2369 (1974).

3. 'Optical Properties of Silver Colloidal Centers in KCl Crystals', J. Phys. Chem. Sol. 35, 1231 (1974).
4. 'Optical Extinction of Silver Colloidal Particles in KCl Crystals', Sol. St. Commu. 15, 436 (1974).
5. 'Optical Extinction due to Potassium Colloidal Particles in KCl Crystals: their Size Distribution', J. Phys. C Z, 3427 (1974).
6. 'Low Temperature Effect on Optical Absorption due to Silver Colloids', Sol. St. Commu. (In Press).
7. 'Conduction Electron Spin Resonance of Silver Particles in KCl Crystals', Phys. Stat. Sol. (To be published).
8. 'Photoconductivity due to Metallic Colloidal Particles Embedded in Crystals, J. Phys. C. (To be published).

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