EPR, OPTICAL AND ELECTRICAL STUDIES OF SOME IONIC CRYSTALS

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Mr. R. Singh was asked to work with the candidate, Shri R.K. Jain, to get some training on EPR. He was, therefore, associated with the work on single crystals of α-MnS included in this thesis. Dr. G.D. Sootha made useful suggestions in interpreting the optical work on KCl:Cd crystals. Except for the minor assistance received from Mr. Singh and Dr. Sootha, whole of the work reported in this thesis has been done, almost independently, by the candidate under my supervision.

(S.C. Jain)

PREFACE

Extensive studies of trapped electron and trapped hole centers have been made in alkali halides and their models are well known. The optical properties of alkali halide crystals deliberately doped with Ca, Ba and Sr have also been studied extensively. However, only a few papers have appeared on alkali halide crystals doped with group IIB impurities. Similarly not much work has been done on other ionic crystals. Most of the papers, which have appeared on wide band oxides and transition metal oxides, are on powders containing unknown background impurities.

The author has investigated experimentally the defect sensitive properties of three typical ionic materials : Cd doped KCl single crystals, highly pure and deliberately doped (with Cr and Mn) MgO single crystals and Cr_2O_3 powders and single crystals. Optical, electrical, EPR, thermoluminescence and magnetic susceptibility measurements have been made on these crystals. Some work on α-MnS single crystals (though the crystals are not ionic) has also been done.

The thesis is divided in five chapters. The results of earlier workers, which are relevant to the work reported in this thesis, are described in the first Chapter. The experimental techniques used by the author are described in Chapter 2. The results on the EPR absorption of highly pure and doped (with Al_2O_3 or Al metal) Cr_2O_3 powder and Cr_2O_3 and α-MnS single crystals are discussed in Chapter 3. The results on the electrical conductivity, EPR and optical

absorptions and thermoluminescence of pure and doped (with Mn and Cr) MgO crystals are discussed in Chapter 4 and the EPR and optical absorptions and the electrical conductivity of Cd doped KCl crystals are discussed in Chapter 5. A summary of the results discussed in every chapter is given as an abstract in the beginning of the chapter.

The author has published the following papers :

1. Electron paramagnetic resonance absorption and other physical properties of chromium oxide and other crystals containing chromium as impurity, S.C. Jain and R.K. Jain; Anisotropy in Single Crystal Refractory Compounds, Eds. F.W. Vahldiek and S.A. Mersol (Plenum Press, New York, 1968) Vol. 1, p. 391

2. EPR absorption in α-MnS single crystals, S.C. Jain, R. Singh and R.K. Jain, J. Phys. Chem. Solids 29, 1703 (1968)

3. EPR studies of highly pure, pure and doped Cr_2O_3 powder, S.C. Jain and R.K. Jain - To appear in the proceedings of "International Conference on Science and Technology of Non-metallic crystals" New Delhi, 13-17 January, 1969.

4. Optical, ESR and electrical studies of colored KCl crystals doped with cadmium, S.C. Jain, G.D. Sootha and R.K. Jain, J. Phys. C. (Proc. Phys. Soc.) 1, 1220 (1968)

5. Non-linear temperature dependence of Debye-Waller factor, A.P. Jain and R.K. Jain, Physics Letters 25A, 187 (1967)

The work reported in the paper entitled "Non-linear temperature dependence of Debye-Waller factor" has not been included in the thesis.

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The author wishes to place on record his sincere thanks to the members of the Solid State Physics Division, particularly Dr. D.C. Parashar and Dr. G.D. Sootha, and Dr. A.P. Jain of Basic Physics Division of National Physical Laboratory, New Delhi, for useful discussions and help rendered during writing of the thesis.

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CONTENTS

CHAPTER 5 : OPTICAL, ELECTRICAL AND EPR STUDIES OF COLORED KCl CRYSTALS DOPED WITH CADMIUM