CHAPTER- V

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Summary and Conclusions

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Iron-oxide has three valuable properties for the storage and conversion of solar energy (i) It has high stability against photocorrosion (ii) It is inexpensive and electrode fabrication is easy (iii) Its band-gap is close to the value required for achieving the maximum conversion efficiency. The stability of Fe_2O_3 against photocorrosion is attributed to the fact that the optical transition, leading to the generation of electron hole pairs, is a d-to-d transition and hence not bond breaking. In contrast, most of the lower band-gap materials do undergo photocorrosion. Thin iron-oxide films, therefore, are widely used for the storage and conversion of solar energy.

These films are usually deposited using vacuum evaporation, spray pyrolysis, chemical bath and dip and dry techniques. However, the areas of the films grown using these techniques are restricted owing to the geometry of the substrate and the source material. Therefore, a novel technique for the growth of uniform large area films, using a solution-gas interface technique, has been developed by the author in the present course.

The work that has been carried out is distributed into five different phases. Chapter I open with a brief survey of solar cells, solar energy materials and oxide semiconductors. The purpose of the dissertation is stated at the end of the Chapter I. Chapter II is devoted to give the sufficient theoretical background based on the existing literature.

The experimental details and growth mechanism of iron oxide semiconductors, namely, Fe_2O_3 is described in Chapter III. The effect of various preparative parameters such as composition of the solution, pH of the solution and exposure time of the gas, on the growth of the film, is studied systematically and discussed in Chapter III. First part of Chapter IV is devoted to explain the experimental set-ups for the study of structural, optical and electrical properties of Fe_2O_3 films formed by solution-gas interface technique. In the second half part of Chapter IV, the results obtained on the structural, optical and electrical studies are reported and discussed.

Finally, the high lights of the investigations are summarized in brief.

Growth of Thin Film by Solution-gas Interface Technique

Solution gas interface, a new technique is developed in our laboratory for the deposition of uniform large area thin films of Fe_2O_3. The method is simple and reproducible one, in which large area thin films on a variety of substrates can be deposited. In the present investigation, thin films of Fe_2O_3 are prepared by this method; their growth mechanism and influence of various preparative parameters are studied.

Basically the method consists of the formation of thin film of semiconductor at the interface of the solution and gas. The solution contains cations and gas contains anions, the product of which by a simple chemical reaction forms the required semiconducting film at the interface. Experimental results, on the properties of solution-gas interface grown films, are greatly influenced by various preparative parameters, namely, composition of the solution, pH of the solution and the exposure time of gas. These preparative paramaters are optimized in order to have the optimum film thickness in the range .2 µm to .8 µm. It is possible with this technique to deposit uniform films of areas as large as 50 cm^2.

Structural, Optical and Electrical Properties of Fe_2O_3 Films

As we are interested in the development of materials for the efficient solar energy conversion devices, it is necessary to study the structural, optical and electrical properties of Fe_2O_3 films. For these studies the following techniques were employed.

(i) Thickness Measurement

(ii) Microstructure

(iii) Optical Absorption

(iv) Dark Conductivity and

(v) Thermoelectric Power (TEP)

The Fe_2O_3 films were prepared by solution-gas interface technique. These films were formed at the interface of $FeCl_3$ solution and ammonia gas. The effect of composition of solution on the thickness of film was studied. It is observed that the film thickness increases with concentration of the solution and attent steady value at the concentration 2 M.

Optical measurement were carried out within the wavelength range

4000 A° to 8000 A°. Absorption coefficient, determined from the above measurement, was found to be of the order of 10^3 to 10^4 cm^{-1}. Fe_2O_3 is indirect band-gap material. The large absorption coefficient obtained may be due to overlapping of at least two absorption bands. The overlapping gives the process of charge transfer from metal to metal. The graph of $\alpha^{\frac{1}{2}}$ versus hν revealed the band-gap energy equal to 1.9 eV.

Dark conductivity of Fe_2O_3 film was studied with two probe d.c. meter in the temperature range 300 °K to 500 °K. It was found that conductivity increases with temperature, which predicted that material is a semiconductor. Activation energy, determined from this measurement, was .17 eV to .9 eV and it is in the same range reported by others in earlier. Thermoelectric power measurement revealed that Fe_2O_3 is n-type.