

PREPARATION AND CHARACTERIZATION OF SPECTRALLY
SELECTIVE SURFACES AND PHOTOTHERMAL CONVERSION DEVICES

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CERTIFICATE

I am satisfied that the thesis entitled 'Preparation and Characterization of Spectrally Selective Surfaces and Photothermal Conversion Devices' by Ramesh Chandra Agarwal is worthy of consideration for the award of the Degree of Doctor of Philosophy and is a record of the original bonafide research work carried out by him under my guidance and supervision. The results contained in it have not been submitted in part or full to any other University or Institute for award of any Degree/Diploma.



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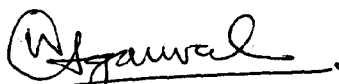
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(Ramesh Chandra Agarwal)

PREFACE

In this thesis an attempt has been made to prepare spectrally selective surfaces of chromium, lead, nickel, cobalt and lead-nickel complex by spray pyrolysis technique, which is quite simple and economical. Characterization of these coatings have also been done, which include absorptivity and emissivity measurements, heating tests, stagnation temperature, reflectance measurements, surface topography using SEM and Auger studies to determine the composition of the coatings. An analytical method has been proposed for selection of the best coating for a given set of operating conditions. Studies have also been made on flat plate collectors with reference to number of glazings, solar flux, emissivity and absorptivity of the absorber surface. Experiments have been done to determine the improvement in solar collector performance due to the spectrally selective spray deposited black cobalt coating on aluminium panels over that of black painted solar collector with single and double glazings. A polythene spiral solar water heater has also been designed and developed. Studies have been done to predict the rise in water temperature and loss in pressure head with the increase in spiral length for different inlet water temperatures and flow rates. The work presented in the thesis has been divided into seven chapters.

Chapter-1, briefly discusses different types of solar collectors, desirable properties of solar selective surfaces and various methods of preparing selective coatings such as electrodeposition, vacuum evaporation, chemical conversion, spray pyrolysis, chemical vapour deposition etc. Chapter-2, gives details of experimental techniques used for preparing spray coatings and some of the instruments used for characterizing them. Chapter-3, deals with the preparation and characterization of the coatings such as heating tests, stagnation temperature, spectral reflectance, surface texture and Auger studies to determine the composition of the coatings. Chapter-4, gives the details of the studies on flat plate collectors with reference to number of glazings, solar flux, emissivity and absorptivity of the absorber surface. The details of an analytical method for optimising a set of (α, ϵ) values for specified set of operating conditions are also given in this Chapter. Chapter-5, gives the details of the experimental studies carried out to determine the improvement in solar collector performance due to the spectrally selective spray deposited black cobalt coating on aluminium panels over that of black painted solar collector. Chapter-6, gives the details of the studies carried out on a spiral solar collector. Chapter-7, gives the general conclusions of the entire work included in the thesis and some suggestions for future work.

A part of the work presented in the thesis has resulted in the following research papers published/accepted/communicated:

1. 'Circular Solar Water Heater', Energy J. Urja, Vol.5, No.7 (1979).
2. 'A Black Liquid Solar Collector', Sunworld, Vol.3, No.4 (1979). (This is not included in the thesis).
3. 'Performance Evaluation of Spiral Solar Collector', National Solar Energy Convention, Bombay, India (1979).
4. 'Tubular Solar Collector', Applied Energy, Vol.6, 125 (1980).
5. 'Pressure Loss in a Spiral Solar Energy Collector', Applied Energy, Vol.6 (1980).
6. 'Spectrally Selective Surfaces for Photothermal Conversion of Solar Energy', Physica Status Solidi(a) Vol. 60, 11 (1980).
7. 'Optimization of the Performance of a Spiral Solar Collector', Applied Energy (In Press).
8. 'Preparation and Characterization of a Spectrally Selective Black Chrome Coating for Solar Energy Applications', Applied Energy (In Press).
9. 'Study of Various Factors Influencing Solar Energy Collector Efficiency', Applied Energy (In Press).

10. 'An Analytical Approach for Optimising a set of α and τ Values for Solar Energy Applications', Energy Conversion and Management, Vol.20, No. 3 (1980).
11. 'Incentives of Spectrally Selective Blacks in Solar Energy Collectors', (To be presented at NSEC, Dec. 1980 Annamalainagar, India).
12. 'Bond Studies on a Flat Plate Solar Energy Collector', (To be presented at NSEC, Dec. 1980, Annamalainagar, India).
13. 'Studies on Lead Sulphide Coatings for Solar Energy Applications', (Communicated).
14. 'Spectrally Selective Lead-Nickel Complex Coatings for Photothermal Conversion of Solar Energy', (Communicated).

