بسم الله الرحمن الرحيم

MONA MAGHRABY

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

MONA MAGHRABY

شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

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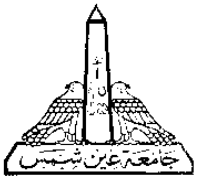

AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Design and Production Engineering

Solar Selective Coating Design and Implementation *via* Sol-Gel Technique

A Thesis submitted in partial fulfilment of the requirements of the degree of

Master of Science in Mechanical Engineering

(Design and Production Engineering)

by

Fatma Taha Abdollah Sabrah

Bachelor of Science in Mechanical Engineering
Faculty of Engineering, Helwan University, 2012

Supervised By

Prof. Dr. Nahed El-Mahallawy

Prof. Dr. Madiha Shoeib

Cairo - (2021)

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Date: -- / -- / 2021

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Date: -- / -- / 2021

Statement

This thesis is submitted as a partial fulfilment of Master of Science in Mechanical Engineering, Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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Thesis Summary

This thesis reports on the efforts made to research and develop solar selective coating, which is considered to be a key element of solar thermal collectors, in an attempt to highlight the importance of increasing knowledge in this field. This aim was accomplished by reading and discussing previous scientific publications relating to this field, and then choosing the solar selective coating composition and preparation method that seemed promising and preferable from several aspects, setting, and implementing a work plan, and subsequently, discussing and evaluating the findings that presented substantial conclusions served the aim of this thesis.

The present study investigates the effect of different process parameters on the optical properties of prepared solar selective surfaces made of stainless-steel sheets coated with $CoCuMnO_x$ solar selective coating, which was prepared and applied through the sol-gel dip-coating method. This is in addition to investigating the inclusion of different mass fractions of different carbon allotropes in the $CoCuMnO_x$ coating structure, besides attempts to apply carbon on top of the $CoCuMnO_x$ selective surface. Furthermore, bare stainless-steel sheets were considered to be solar selective surfaces after processing the sheets by thermal exposure and roughening their surfaces. X-ray diffraction, Scanning Electron Microscope, and Energy-dispersive X-ray were the used analysis methods to identify the phase composition, topography, and elemental composition, respectively, of some featured samples.

The performed study revealed outstanding spectral characteristics for the roughened stainless-steel sheet coated with two layers of charcoal-$CoCuMnO_x$. A 5 wt.% of charcoal embedded in the structure of $CoCuMnO_x$ managed to surpass the plain $CoCuMnO_x$ solar selective coating with 7% higher spectral selectivity. Noting that the plain coating achieved an absorptivity of 0.906, an emissivity of 0.116, and 85% selectivity, while the developed version, which contained carbon, achieved an absorptivity of 0.964, an emissivity of 0.095, and 92% selectivity. In addition, it was found that annealing bare stainless-steel sheets with a surface roughness of 1.35 μm at 750 °C yielded a solar selective surface with an absorptivity of 0.953, an emissivity of 0.205, and 85.1% selectivity. Moreover, it was evidenced that the roughness degree of the substrate surface has a substantial potential to boost optical properties.

Keywords: Solar selective coating, Sol-gel, $CoCuMnO_x$, Carbon allotropes, $C@SiO_2$, Silica, optical properties, Surface roughness, Stainless-steel

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