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Using Oxide Materials for Improving Solar Collectors

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Abstract: ***In this paper we preparation and testing of the solar thermal collector using (chromium oxide, nickel oxide and copper oxide) coatings. This type of absorption is the most expensive way to prepare such absorption. The basic characteristics of the coating are prepared on the aluminum and copper substrates. To improve thermal compound properties. Optical properties were measured with the UV spectrum. While the emissivity of the surface is effective in energy emission and thermal radiation, so the results showed that when the concentration of each coated concentration increased from 0.1-0.3 (M), the increased emissivity of solar aggregation increased and the layers increased emissivity and improved solar energy. Collected`.***

Keywords: Emissivity, Solar Collectors and Optical Properties

1. Introduction

Collectors defined the device used for solar radiation captured. Their core innovation is the ability to collect heat by absorbance the sunlight. Absorbance surface which is have important role for converting the incident solar radiation to thermal energy, is made of absorbent metals coting by darks colors to increase absorbance. Emissivity radiation property surface describes involving heat transfer by electromagnetic radiation arising due to the temperature of the body. We can define emissivity as the ratio of energy emitted from the material emitted by the black body energy (a body that emits as much as possible from the heat to the absolute temperature of the so-called black body, which means that a black body completely absorbs the incident radiation on this, and at the same time it emits all the energy that it absorbs with the same absorbing spectrum. That is to say, ε=1) at the same temperature, which is described by Eq. (1): [1-4]

$$\varepsilon(T) = \frac{\int_0^\infty \varepsilon(\lambda) E_\lambda \, d_\lambda}{\sigma T^4} \quad \ldots\ldots \; 1$$

Where ε is radiant heat of gray body to its surroundings, ε hemispherical emissivity of the gray body (dimensionless), σ Stefan– Boltzmann constant (5.67×10^{-8} W/($m^2\times K^4$)), T temperature (K).

So the absorbing collector must be collective a maximum energy used a high absorptance coating with low emittance for re-radiation (long wave length) . such surface referred to as a selective surface . the absorptance of the collector surface for short wave solar radiation depends on the nature and color of the coating and on the incident angle . usually black color is used , but various color coating have been proposed by the [5,6]

By suitable electrolytic or chemical treatment , surfaces can be produced with high values of solar radiation absorption (a) and low values of longwave emittance ε , essentially , typical selective surface consist of thin upper layer which is highly absorbent to shortwave solar radiation but relatively transparent to longewave thermal radiation deposit on a surface that has a high reflectance and low emittance for long radiation.

Most important selective materials which used for solar collectors, Cr_2O_3 thin films exhibit high order of hardness with high wear and corrosion resistance that are important properties for protective coating. Black chrome plating is supposed to be useful for Solar applications but could anybody explain how a black coating can have good absorption and poor emissivity with high temperature applications [7].

The second most important materials used in coating solar collectors Copper(I) oxide with the formula Cu_2O. It is one of the principals oxides of copper, the other being Cu_2O . This red-colored solid is a component of some antifouling paints[8].

2. Materials and Methods

The absorber surface of solar radiation which prepared using casting methods, through using each types of oxide (chromium, nickel and copper).

Before casting each oxide coating, each substrate's roughness was enhanced by employing using grinding with emery paper and was cleaned with the following scheme: acetone solution → distilled water → aqueous solution of 10% H_2SO_4 → distilled water. After cleaning process, the substrates were dried in hot air oven at 100 C° or one hour. Then Preparation of samples paints were prepared by casting methods applied on Aluminum and Copper sheets with size 7x7 cm. In order to achieve different weights of paint per m^2, spraying time was changed. When the paint was applied by draw bar coater the appropriate coater was used to change the layer thickness. The optical absorbance was recorded by UV/1800/ Shimadzu spectrophotometer in range of wavelength (300-800) nm.

Measurements absorbance and emittance values, emittance measured using TIR 100-2 device Inglas Co., Germany. The emissivity results tacking at 100C°

3. Results

The UV–Vis absorption spectra of copper oxide, nickel oxide and chromium oxide is shown in figure (1,2 and 3).

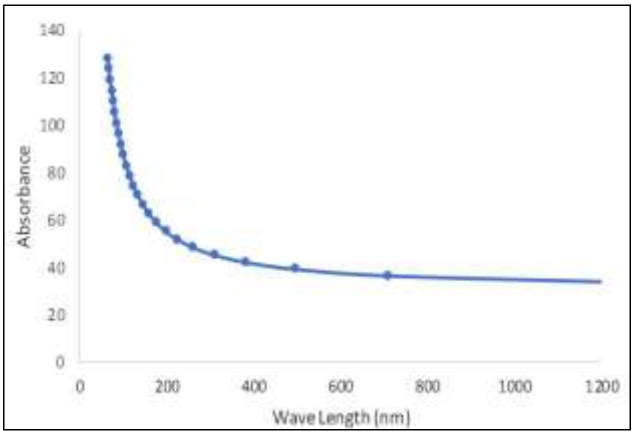

Figure 1: UV–Vis absorption spectra of (Cr_2O_3)

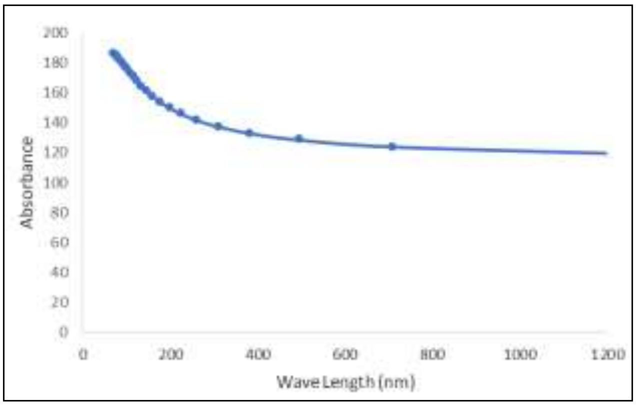

Figure 2: UV–Vis absorption spectra of (Cu_2O)

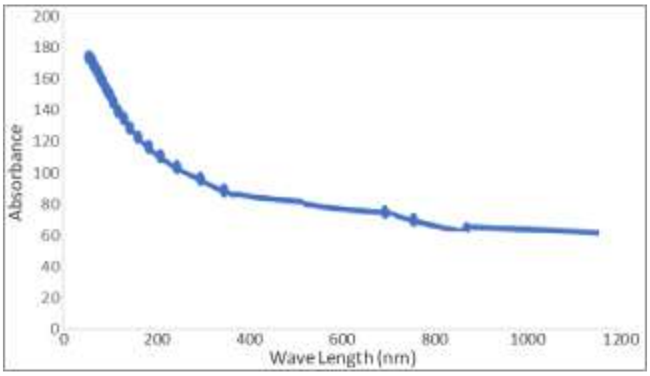

Figure 3: UV–Vis absorption spectra of (NiO)

Coatings of copper oxide, nickel oxide and chromium oxide (Cr_2O_3) are used on copper substrates as one layer but in two concentrations (0.1 and 0.3) M and as two types of paints as two layers ad in three layers the results.

The emittance (ε) of pure copper, pure aluminum 0.006, 0.05

Table 1: Shows the Emittance (ε) of Various Coatings on Copper Substrate.

Type of coating	Concentration M	One layer	Two layers	Three layers
Copper Oxide	0.1	0.128	0.43	
	0.3	0.40		
Nickel Oxide	0.1	0.139	0.32	0.509
	0.3	0.167		
Chromium Oxide	0.1	0.369	0.5	
	0.3	0.480		

Table 2: The Emittance (ε) of Various Coatings on Aluminum Substrate.

Type of coating	Concentration M	One layer	Two layers	Three layers
Copper Oxide	0.1	0.53	Cu_2o_3+NiO_3	
	0.3	0.88	0.908	
Nickel Oxide	0.1	0.565	Cu_2O_3+Cr_2O_3	0.920
	0.3	0.7	0.902	
Chromium Oxide	0.1	0.74	Cr_2O_3+NiO_2	
	0.3	0.89	0.898	

From tables (1 and 2) results showed that increasing concentration and increasing layers of coating caused increasing emissivity because of the interference effects of reflected light between various interfaces layers. The characteristic pattern of multilayer of incident solar radiation the total emittance increased where in aluminum substrate increased from 0.53 in one layer to 0.920 in three layers this result have the same behavior with results in reference [10]

4. Conclusion

1) Obtained results show that spectrally solar collectors coating prepared on two different substrates.
2) The concentration of oxides materials increased the emissivity of application of paint strongly influences on final spectral selectivity.
3) The better results were obtained when the paint was applied by three layers of chromium oxide, copper oxide and nickel oxide.

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