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Characterization of a copper susceptor sensitive to solar IR and UV radiation

Caracterización de un susceptor de cobre sensible a radiación solar IR y UV

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Abstract

Renewable energies use has become the best alternative to reduce the damage effects due to global warming. In this work it is presented the characterization for a copper susceptor being sensible to IR and UV sun radiation, the susceptor was installed in the focus of a parabolic antenna reaching temperatures around 300°C. The susceptor is elaborated from type "K" thermocouples as transducers from heat energy to electric energy, thermocouples were mounted on a copper bar which received a chemical treatment in order to obtain an oxide film sensible to IR and UV sun radiation it is shown the absorption specters of the film taking as a reference the air absorption spectres measured with a BRUKER® equipment. Thermocouple array consist of 800 elements connected on parallel and series, final setup will be disposed in a configuration able to reduce atmospheric perturbations and absorb the high sun radiation values available at UPTlax Campus, it has been evaluated the effectiveness of the presented technology as a viable proposal that could be an alternative to the conventional silice photovoltaic cells.

Renewable energies, Solar Energy, Susceptor, Thermocouple, Sun Radiation

Resumen

El uso de energías renovables se ha convertido en la mejor alternativa para disminuir los graves efectos del calentamiento global. En el presente artículo se muestra la caracterización de un susceptor de cobre sensible a radiación solar IR y UV el cual fue instalado en el foco de una antena parabólica alcanzando temperaturas alrededor de 300 °C, el susceptor está elaborado a partir de termopares tipo "K" como transductores de energía calorifica a energía eléctrica colocados en una placa de cobre, en la cual se depositó una película de óxido sensible a radiación solar IR y UV, se muestran los espectros de absorción del recubrimiento del cobre tomando como referencia los espectros de absorción del aire, obtenidos con un equipo BRUKER®. El arreglo de termopares consta de 800 elementos conectados en serie y paralelo, el dispositivo final será colocado en una configuración que permita minimizar las perturbaciones atmosféricas aprovechando los altos valores de radiación solar que se tienen en el Campus UPTlax, se ha evaluado la efectividad de la tecnología dando como resultado una propuesta viable que permitirá ser una alternativa a las celdas fotovoltaicas de silicio convencionales

Energías Renovables, Energía Solar, Susceptor, Termopar, Radiación Solar

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Introduction

The traditional way to give the solar radiation susceptors the black color is by placing epoxy paints, which are relatively thick layers reducing the efficiency of capturing solar radiation, in addition they do not withstand high temperatures, in this case, the suceptor will be placed in the focus of a parabolic antenna [1], which gives temperatures around 300 ° C. The coloring of the suceptor proposed in this work is through a chemical deposit creating a thin film of matt black copper oxide.

The coloration of the metals is generated on the surface of the metal, suitably grown to produce a deposit adherent to the metal of colored substances arranged in a very thin layer so as to produce the impression of a uniform coloration that does not influence the metallic character, for which will grow a surface film of copper oxide chemically sensitive to IR and UV radiation. The manufacture of this type of heat energy to electrical energy transducers is important because of the manufacturing technique which is not economically and technologically comparable to the silicon solar cell manufacturing technique.

As a thin coating was used, it turns out that minor variations in the chemical and physical constitution of the metal surface, such as small impurities bound in the manufacture of the alloys, exert a lot of influence on the metallic coloration aspects. From this it follows that the prescriptions for the coloring of metals are in the state of the art.

In section 2 the description of the method is presented, the optimal reaction with which the best result is obtained according to the absorption spectra shown, in section 3 a table with the most relevant experimental results is shown, in section 4, it is presents a brief discussion and some photographs of the prototype of the suceptor, finally in section 5 a general conclusion of the work presented is shown Text written in Times New Roman No.12, single space.

Method description

Matte black copper coloration

There are several ways and methods of coloring copper [2], [3], [4], in this article the simplest and most economical method is shown which is heating a solution of caustic soda to the boiling point, at which Potassium persulfate is added to it by means of the boiling solution and in continuous intense reciprocating movement, a matte black film is formed on the surface that allows even reducing and staining copper imperfections in figure 1 some results are shown.

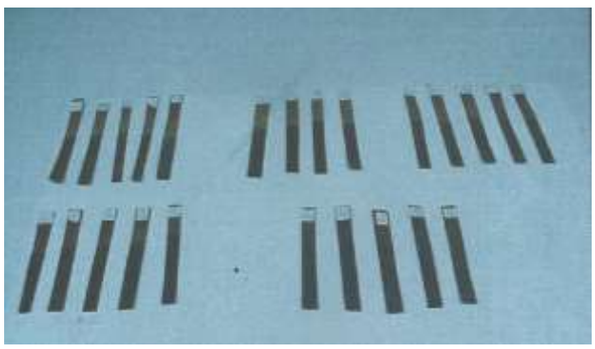
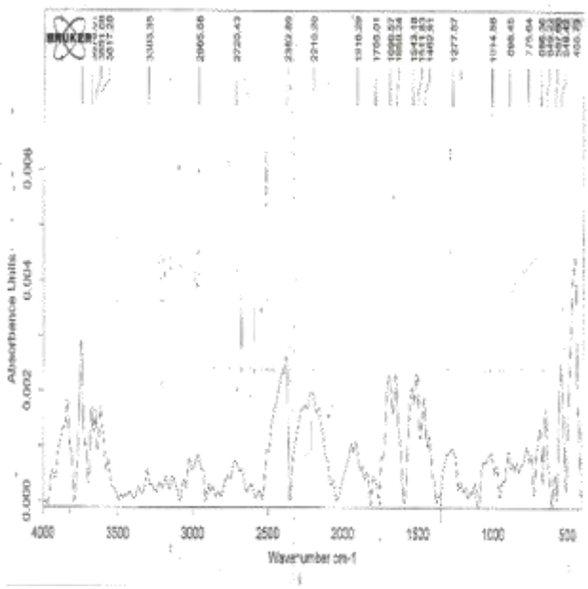


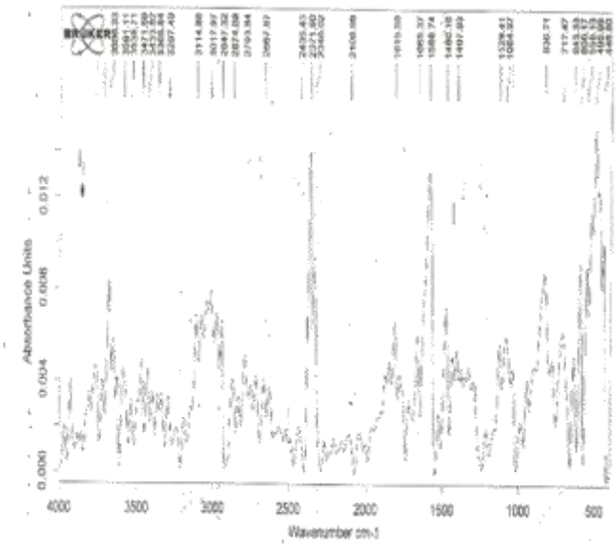
Figure 1 Samples of copper oxide films on copper substrates

Characterization

A characterization of the samples was carried out through the absorption spectra with a Bruker® brand spectrometer. In Figures 2 (a) and 2 (b), IR absorbance spectra are shown for different thickness values of the deposited oxide. In figure 3, the absorption spectrum of air is presented.



(a)



(b)

Figure 2 IR absorbance spectra of samples

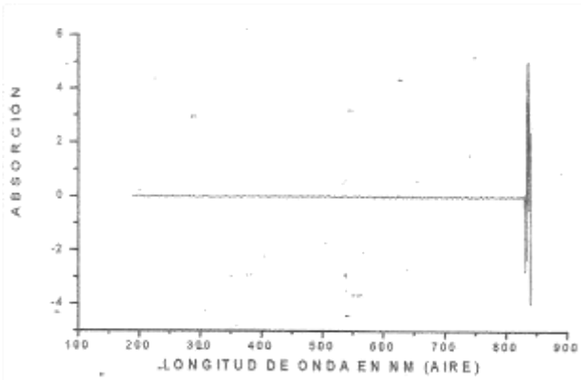


Figure 3 Air absorption spectrum

Figure 4 shows the absorption spectrum with the highest peaks that were obtained, these are corresponding to the wavelength around 597 NM.

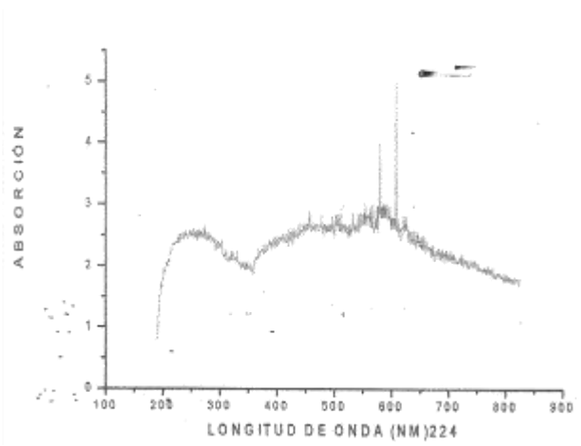


Figure 4 Absorption spectrum with the highest peaks

Figure 5 shows a spectrum with a comparison of the plates with the highest absorption, the maximum absorption at 605 NM wavelength is the upper curve.

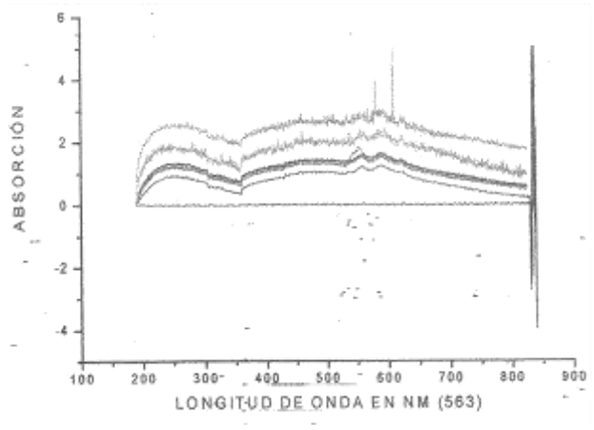


Figure 5 Samples with maximum absorption

Results

Table 1 shows the absorption values for each sample, in which the most relevant values are highlighted.

No. Shows	Average absorbance	No. Shows	Average absorbance
121	1.2	342	1.31
124	1.2	363	1.37
142	1.19	412	1.52
163	1.39	**421**	**1.61**
212	1.33	**424**	**1.58**
221	1.35	442	1.43
224	**3**	463	1.12
242	1.38	**512**	**2.4**
263	1.1	**524**	**1.83**
312	1.31	542	1.45
321	1.33	**563**	**1.54**
324	124	**564**	**1.53**

Table 1 Most relevant values of the samples

Figure 6 shows the increase in the level of absorption between a traditional film and a chemically treated film for IR and UV solar radiation (IR and UV upper curve and with IR sensitive oxide lower curve).

Figure 6 Comparison between movies

An experimental measurement was carried out by placing the susceptor in the focus of the parabolic antenna as shown in figure 7.

Figure 7 Satellite dish

Conclusions

Applying the oxidation-reduction technique it was possible to obtain a matte black film with absorbance characteristics in IR and UV, adhesion and durability much better than conventional epoxy paint film.

Thermal efficiency increased by 18% and temperature increased by 21 ºC

With the experimental arrangement it was possible to capture a voltage value of 50mV at a temperature of 230 ° C with a number of 10 thermocouples, it is planned to increase the number of thermocouples in order to use electrical energy to recharge batteries.

Acknowledgments

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