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Preparation, Sem Characterisation And Proportion Optimization Of Nano Composite Based Cost Effective Solar Absorber

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ABSTRACT

The merge of solar technology and nano technology is the need of the hour, as this combination can enhance the thermal performance of solar collector. In this connection, it is essential to prepare the nano-composite based absorptive coating for its usage in solar absorbers. It is also essential to characterize the absorptive coating and optimize the proportion of the constituents of the nano-composites. In the present investigation, the nano-composite based absorptive coating was prepared and it was coated on galvanized iron absorber. The prepared coating was characterized and it was found that the sizes of grains were in nano scales. The proportion of the constituents of the nano-composite was optimized and the optimal ratio of carbon and metal oxide was 75:25. On the basis of the generated reliable database of the present investigation, it could be concluded that the nano-structured solar absorber (especially with optimal quantity of constituent based nano-composite coating) would be used in solar collectors not only to have enhanced absorption of radiation but also to have cost effectiveness.

KEY WORDS : Nano-structured solar absorber – SEM characterization – Proportion optimization of absorptive coating – Energy Efficacy

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INTRODUCTION

Preparation, characterization and utilization of nano-composite based solar absorbers are mandatory, as the solar absorbers that are now in use in solar collectors are large in size and also expensive. In this connection, it is essential to (i) prepare the nano-composite based coat effective solar absorber, (ii) characterize the nano-composite based cost effective solar absorber and (iii) optimize the ratio of carbon and metal oxide in the cost effective solar absorber. All these mandatory objectives are to be materialized so as to reap the energy and economic benefits and hence the present investigation. The research outcomes have been documented in the present research paper for the benefit of manufacturers, researchers and end users of solar thermal gadgets.

EXPERIMENTAL

In the present investigation, the nano-structured absorber in standard size was prepared and it was integrated with the solar collector. Initially, the nano-sized carbon was prepared from charred coconut shell and the nano-sized metal oxide was commercially procured. Subsequently, the nano-sized carbon and metal oxide was mixed up in different ratios such as 75:25, 50:50 and 25:75 and the present nano-composites were blended in black emulsion. Finally, the resultant solution was coated on the pre-cleaned galvanized iron substrates by spray coating method. The sample absorber was characterized through SEM analysis and the ratio optimization of nano-composites was studied by testing the solar collector integrated with galvanized iron absorber having nano-composite coatings in three different ratios.

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FINDINGS AND CONCLUSION

In the present investigation, nano-carbon based cost effective absorber was prepared and it was characterized. In addition, the ratio of nano carbon and metal oxide was optimized so as to have maximum absorption of solar radiation. The characterization outcomes of the microscopic and SEM analyses have been presented in figure 1 and figure 2. The research outcomes of the ratio optimization studies have also been presented in Table 1.

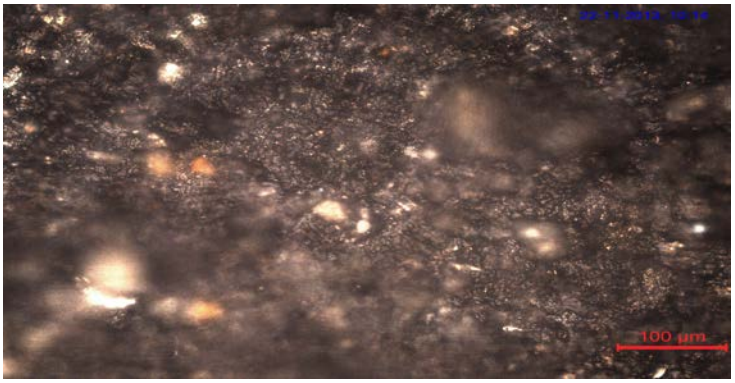

Figure 1 : Microscopic image of carbon and metal oxide

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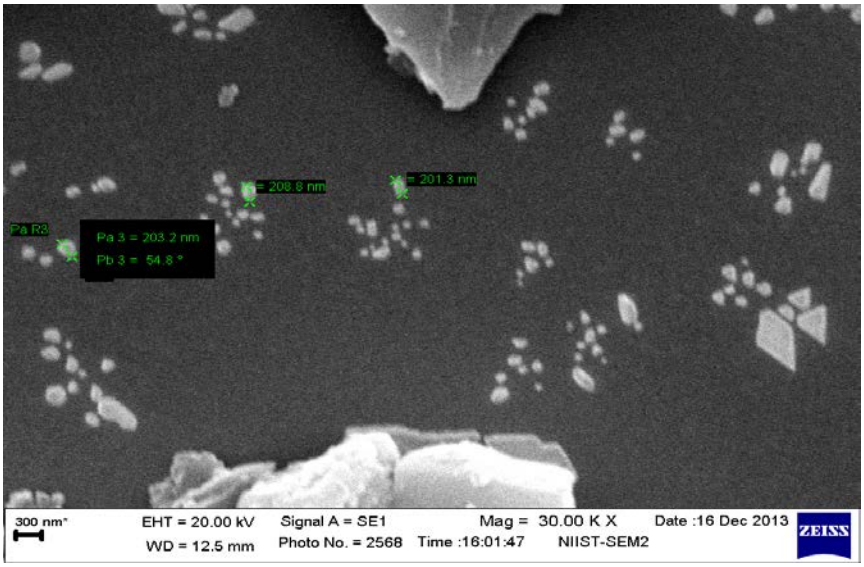

Figure 1 : SEM image of carbon and metal oxide

The microscopic images of the carbon nano particles and morphology of metal oxide on the absorber plate showed square, cubic, spherical and triangular edged micro patterns. Of course, the structure of the carbon and metal oxide samples were analyzed by using a scanning electron microscope (SEM). The outcomes of SEM revealed the surface characteristics and the chemical constitutes of the coating that was deposited on the absorber. The measurable parameters provided the size of carbon and metal oxide particles and they were in the size range from 62.7 nm to 108.8 nm.

Table 1 : Temperature enhancement of working fluid

Ratio of nano carbon and metal oxide	Temperature enhancement (Minimum) ^{o}C	Temperature enhancement (Maximum) ^{o}C
25:75	33.9	86.9
50:50	34.5	89.2
75:25	35.1	92.7

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The temperature enhancement of the working fluid in solar collector with GI absorber having the nano-composite coating in different ratios was noted periodically during the sunshine hours. The minimum and the maximum temperature enhancements of the working fluid were noted and they have been presented. It was noted that the GI absorber (with nano carbon and metal oxide in the ratio of 25 and 75) integrated solar air heating collector had the rise of temperature that varied from 33.9 ^{o}C to 86.9 ^{o}C. It was noticed that the GI absorber (with nano carbon and metal oxide in the ratio of 50 and 50) integrated solar air heating collector had the elevation of temperature that varied from 34.5 ^{o}C to 89.2 ^{o}C. It was observed that the GI absorber (with nano carbon and metal oxide in the ratio of 75 and 25) integrated solar air heating collector had the elevation of temperature that varied from 35.1 ^{o}C to 92.7^{o}C. On the basis of the thermal enhancements, the ratio of 75 and 25 (carbon and metal oxide) was optimized and this ratio based nano-composite was used for further research works. The thermal enhancements of working fluid could be attributed with the nature of nano absorptive coating, optical characteristics of nano absorptive coating and thermal characteristics of the material of the absorber. On the basis of the generated reliable database of the present investigation, it could be concluded that the solar absorber with nano-composite (with 75% carbon and 25% metal oxide) based coating would be used in solar collectors not only to have enhanced absorption of radiation but also to have cost effectiveness.

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