Soumya Kanti **Hazra**

Indian Institute of Technology Kharagpur, India | Jadavpur University, India
LinkedIn | ResearchGate | Publons | ORCID | Google Scholar

+91 9800540304, soumyakantihazra@iitkgp.ac.in
Nationality: Indian | **Date of Birth:** 14th October 1990

Discipline: Applied Physics | Material Science | Cryogenic Engineering | Renewable Energy

Career Objective: A highly motivated, having experimental physics and interdisciplinary engineering background with hands on experience from materials synthesis to its applications. Looking for a thought-provoking role that will expand my research expertise

Education

Indian Institute of Technology (IIT) Kharagpur — *West Bengal, India*
Doctoral Student at Cryogenic Engineering Centre — January 2017 - January 2022

- Recipient of Ministry of Human Resource Development Fellowship (MHRD) fellowship for five years
- Recipient of Foreign Travel Grant from IIT Kharagpur for attending 9th colloids conference 2019 in Spain
- Thesis title: *Studies on photo-thermal conversion of nanofluids and design optimization of volumetric solar collectors*

Indian Institute of Technology Kharagpur — *West Bengal, India*
Master of Technology in Cryogenic Engineering — June 2013 - May 2015

- Recipient of MHRD fellowship for two years
- CGPA: 8.49/10
- Thesis title: *Magnetodielectric behavior of Cobalt Ferrite-Lead Zirconate Titanate-PVDF multiferroic nanocomposites*

Indian Institute of Technology Kharagpur — *West Bengal, India*
Master of Science in Physics — June 2011 - May 2013

- Recipient of Innovation in Science Pursuit for Inspired Research (INSPIRE) fellowship for two years
- CGPA: 8.05/10
- Thesis title: *Fabrication of thermoelectric power measurement setup to study magnetic oxide material in the temperature range 77-300 K*

Jadavpur University — *Kolkata, India*
Bachelor of Science in Physics — August 2008 - May 2011

- Recipient of INSPIRE fellowship for three years
- Score: 72%

Research Experience

Doctor of Philosophy — *IIT Kharagpur, India*
Supervised by Dr. Tapas Kumar Nandi, Associate Professor, IIT Kharagpur, India — January 2017 - January 2022

- Investigation on photo-thermal conversion characteristics of carbon black, boron nitride based nanofluids using direct absorption solar collector
- Numerical analysis on the performance prediction and design optimization of solar collector

Research Assistant — *IIT Kharagpur, India*
Supervised by Late Prof. Sudipto Ghosh, IIT Kharagpur, India — August - December, 2016

- Analysis of the microstructure of aluminum-lithium alloy

Research Assistant — *Aalto University, Finland*
Supervised by Prof. S. Van Dijken, Aalto University, Finland — March - July, 2016

- Fabrication of multiferroic tunnel junctions and study the resistive switching behavior

Master of Technology Project Fellow — *IIT Kharagpur, India*
Supervised by Prof. Venimadhav Adyam, IIT Kharagpur, India — December 2013 - May 2015

- Magnetic, dielectric and magnetodielectric studies of composite based multiferroic samples

Master of Science Project Fellow — *IIT Kharagpur, India*
Supervised by Prof. Tapan Kumar Nath, IIT Kharagpur, India — July 2012 - May 2013

- Explore thermoelectric response of various magnetic oxide based materials

Skill

Technical Skills:

- **Instrument handled:** PLD | RF-sputtering | XRD | FE-SEM | TEM | AFM | Spectrometer | DLS | LCR meter | PPMS | VSM
- **Instrument fabrication:** Thermoelectric | Magnetodielectric | Direct absorption solar collector

Tool & Software Skills: MS office | Origin | Image J | ANSYS Fluent | C++ | FullProf
Personal Qualities & Skills: Self-Motivated | Hard Working | Team Work | Collaborative | Adaptable
Reviewer of Scientific Journals: Elsevier | ASME | Springer

Publication

Published paper

- Investigations on optical and photo-thermal conversion characteristics of BN-EG and BN/CB-EG hybrid nanofluids for applications in direct absorption solar collectors — *Solar Energy Materials & Solar Cells*
  Authors: S. K. Hazra, M. Michel, T. K. Nandi (2021)
- Photo-thermal conversion characteristics of carbon black-ethylene glycol nanofluids for applications in direct absorption solar collectors — *Applied Thermal Engineering*
  Authors: S. K. Hazra, S. Ghosh, T. K. Nandi (2019)
- Exchange bias effect concerned with tunnelling magnetoresistance in $Sm_{0.35}Pr_{0.15}Sr_{0.5}MnO_3$ phase separated manganites — *IEEE Transactions on Magnetics*
  Authors: S. K. Giri, P. T. Das, S. K. Hazra, T. K. Nath (2013)

Communicated

- Performance prediction and design optimization of nanofluid based direct absorption solar collector
  Authors: S. K. Hazra, T. K. Nandi (2022)

Manuscript under preparation

- Photo-thermal conversion behavior of exfoliated MoS_2 nanofluid for direct solar energy harvesting
  Authors: S. K. Hazra, A. Ghorai, T. K. Nandi (2022)
- Nitrogen doped graphene quantum dot based nanofluids for direct absorption solar collector
  Authors: S. K. Hazra, D. Mandal, T. K. Nandi (2022)

International proceeding

- Fabrication of low cost and high precision thermoelectric power setup in the temperature range of 77–300 K — *AIP Conf. Proc.*
  Authors: S. K. Hazra, S. K. Giri, T. K. Nath (2015)
- Enhanced room temperature magnetoresistance in p-$La_{0.7}Ca_{0.3}MnO_3$/$SrTiO_3$/n-Si heterostructure: a possible spintronics application — *AIP Conf. Proc.*
  Authors: S. K. Giri, J. Panda, S. K. Hazra, P. T. Das, T. K. Nath (2014)
- Design and development of low cost thermoelectric power setup in the temperature range of 30–320 K up to a magnetic field of 8 T — *AIP Conf. Proc.*
  Authors: S. K. Giri, S. K. Hazra, T. K. Nath (2013)

Certified Course/Training

- *Fundamentals of scanning electron microscope and its applications*, organized by Carl Zeiss India Pvt. Ltd
- *Clean room training* and *operator licenses* for twelve instruments in the clean room of Aalto Nanofab and VTT technical research centre of Finland at Micronova, Espoo, Finland
- *Gas safety course* conducted by the AGA, a Linde group member, held at Department of Applied Physics, Aalto university, school of science, Espoo, Finland
- *Chemical training* conducted by Aalto Nanofab and VTT at Micronova, Espoo, Finland

Conference Attended

International

- 9th International Colloids Conference, Barcelona, Spain, 2019 (poster presentation)
- International Conference on Advances in Materials & Materials Processing, IIT Kharagpur, India, 2016 (poster presentation)
- International Conference on Magnetic Material and Applications, IIT Guwahati, India, 2013 (poster presentation)

National

- Advances in Colloidal and Polymeric Systems, Vellore Institute of Technology, India, 2020 (poster presentation)
- 58th DAE Solid State Physics Symposium at Thapar University, India, 2013 (poster presentation)
- 57th DAE Solid State Physics Symposium at IIT Bombay, India, 2012 (poster presentation)

Professional Membership

- Lifetime membership of Magnetics Society of India (LM 612) — December 2013 - Present

Extracurricular Activity

- Served as the research scholars' representative from Cryogenic Engineering Centre for the academic year of 2019-2020
- Acted as the student coordinator in one day technical workshop organized by Cryogenic Engineering Centre, 2018
- Acted as the core head of organizing committee to conduct departmental research scholar s' day, 2017

Solar Energy Materials & Solar Cells 230 (2021) 111245

Contents lists available at ScienceDirect

Solar Energy Materials and Solar Cells

journal homepage: www.elsevier.com/locate/solmat

Investigations on optical and photo-thermal conversion characteristics of BN-EG and BN/CB-EG hybrid nanofluids for applications in direct absorption solar collectors

S.K. Hazra [a,*], M. Michael [b], T.K. Nandi [a]

[a] Cryogenic Engineering Centre, Indian Institute of Technology Kharagpur, West Bengal, 721302, India
[b] Department of Metallurgical and Materials Engineering, Indian Institute of Technology Kharagpur, West Bengal, 721302, India

ARTICLE INFO

Keywords:
Hexagonal boron nitride
Hybrid nanofluid
Direct absorption solar collector
Photo-thermal conversion efficiency

ABSTRACT

Direct absorption using a nanofluid is an efficient way of harnessing solar energy. Present works aim to investigate hexagonal boron nitride-ethylene glycol (BN-EG) nanofluids and BN mixed with carbon black (CB) in EG (BN/CB-EG) hybrid nanofluids for applications in direct absorption solar collectors (DASCs). Nanofluids were prepared by using the two-step method. Stability and homogeneity were inspected photographically after storage of one month. The optical properties of the nanofluids were measured and computed under varying concentration mixing ratios (CMRs). An absorbed energy fraction of 98.92% was obtained in a 2.0 cm height of 90 ppm/15 ppm BN/CB nanofluid. Photo-thermal conversion performances of the nanofluids were investigated using a small in-house built experimental collector. Temperature-rises in the working fluids were measured under varying durations of exposure to a fixed irradiance, fluid height, and CMRs of the nanoparticles. An enhancement of 34.55% photo-thermal conversion efficiency over that of EG alone was obtained in the 90 ppm/15 ppm BN/CB nanofluid after 1200 s exposure to 437 W/m^2 incident irradiance. Some basic approaches for designing a DASC in an optimized manner are also discussed. It is concluded that BN/CB-EG hybrid nanofluids can be the prospective working fluids in DASCs.

1. Introduction

Solar energy, being renewable, abundantly available, and non-polluting in nature, is widely considered and being investigated towards its efficient storage and utilization [1,2]. Photo-thermal conversion in a solar collector, comparing with photo-chemical and photo-voltaic methods, is a more efficient process for storing solar energy [3]. There are mainly two types of solar collectors available in practice, surface absorption and direct absorption [4]. In surface absorption solar collectors, incident radiation is first absorbed in the receiver's surface and then transferred to the working fluid by conduction and convection. Owing to the thermal resistance between the surface and the working fluid, the body temperature of the receiver can be much greater than the working fluid. This may cause a significant amount of radiative energy loss to the surrounding resulting in reduced photo-thermal storage efficiency. On the other hand, in a direct absorption solar collector (DASC) the incident illumination is volumetrically captured by the working fluid and stored in the form of heat. Thus, radiation energy loss from the body is reduced and the energy storage efficiency is improved [4,5].

Commonly used heat transfer fluids (HTFs), such as water, ethylene glycol, engine oil, etc., have very poor absorption characteristics towards the incident solar radiation. When certain nanoparticles are suspended in these HTFs, significant improvements in optical and thermophysical characteristics, hence, in conversion efficiency are achieved [6,7]. Even a very low concentration of nanoparticles, typically a few mg per liter, can improve the energy storage capacity significantly compared to that using the base fluid alone [8].

Photo-thermal conversion of various nanofluids using metals [9,10], metal oxides [11,12], carbon materials [8,13], core-shell [14,15], etc., have been studied over the years. Zeiny et al. [9] experimentally studied the photo-thermal conversion efficiency of individual aqueous solutions of gold, copper, and carbon black. They observed maximum enhancements in the conversion efficiency, over that in the base fluid, of 72%, 100%, and 125% using 150 ppm gold-water, 3000 ppm copper-water, and 100 ppm carbon black-water nanofluid respectively. Chen et al.

* Corresponding author.
E-mail address: soumyakantihazra@iitkgp.ac.in (S.K. Hazra).

https://doi.org/10.1016/j.solmat.2021.111245
Received 20 February 2021; Received in revised form 24 May 2021; Accepted 16 June 2021
Available online 24 June 2021

Applied Thermal Engineering 163 (2019) 114402

Contents lists available at ScienceDirect

Applied Thermal Engineering

journal homepage: www.elsevier.com/locate/apthermeng

Photo-thermal conversion characteristics of carbon black-ethylene glycol nanofluids for applications in direct absorption solar collectors

S.K. Hazra[a,*], S. Ghosh[b], T.K. Nandi[a]

[a] Cryogenic Engineering Centre, Indian Institute of Technology Kharagpur, India
[b] Department of Metallurgical and Materials Engineering, Indian Institute of Technology Kharagpur, India

HIGHLIGHTS

- Carbon black-ethylene glycol (CB-EG) nanofluids were investigated.
- Extinction coefficient increased linearly with CB concentration within 450–820 nm.
- An enhancement of overall photo-thermal efficiency of 27.43% was obtained.
- Local photo-thermal efficiency improves with concentration and depth of fluid.

ARTICLE INFO

Keywords:
CB-EG nanofluid
Direct absorption solar collector
Photo-thermal conversion efficiency
Absorbed energy fraction

ABSTRACT

Direct absorption solar collector (DASC) is a promising method of harvesting solar energy. Present work considers carbon black-ethylene glycol (CB-EG) based nanofluids as the working fluids for DASC applications. Nanofluids were synthesized by the two-step method. Various studies carried out in this work include long time homogeneity, energy absorption characteristic and transient temperature profiles as functions of fluid thickness, light exposure time and concentration of the nanoparticles. Improved absorption characteristics, compared with those of the base fluid, towards incident irradiance were observed in all cases. About 27.90% increment in overall photo-thermal conversion efficiency over that of the ethylene glycol (EG) alone is observed for the case of 15 ppm carbon black (CB) concentration with an exposure time of 1200 s. Measured data show increasing trends in local photo-thermal efficiency with the thickness of the liquid layer as well as with the concentration of the suspended nanoparticles. These studies confirm that CB-EG based nanofluids can be used as potential working fluids for DASCs.

1. Introduction

Fossil fuel based conventional energy sources are generally responsible for global warming and environmental pollution [1]. Thus, the renewable energy sources have become alternative options for meeting the energy demand in utility sectors [2]. Solar energy is one of the commonly used substitutes for energy source due to its clean nature, abundance and free availability [3]. Solar radiation in the ultraviolet–visible range is used in electric energy production through photo-electric conversion [4]. On the other hand, the entire range of wavelength in the solar spectrum can be used for producing heat energy by photo-thermal conversion [5]. Compared to solar photo-electric conversion, photo-thermal conversion is less complex, straight forward and an efficient means of utilizing solar energy [1].

A solar collector is a device in which the energy of the incident solar radiation is stored in the form of heat energy [6]. Conventionally, in a surface absorption based solar collector the incident solar heat flux is at first absorbed in a surface and then dissipated into the working fluid [7,8]. Conductive resistance in the absorbing surface and convective thermal resistance within the fluid are present in this process of energy dissipation causing reduction of photo-thermal conversion efficiency [9,10]. Abdelrahman et al. [11] showed that in a concentrated solar collector, the temperature of an absorbing surface could be as much as 500 °C higher than that of the working fluid. This can lead to a significant radiative energy loss from the absorber, which is proportional to the fourth power of the temperature. Besides, surface-based absorbers have their own limitations on absorption and transmission of incident radiation depending upon the available surface area of the collector [12]. Minardi and Chuang [13] in the year 1975 first proposed the concept of a direct absorption solar collector (DASC), where the

* Corresponding author.
E-mail address: soumyakantihazra@iitkgp.ac.in (S.K. Hazra).

https://doi.org/10.1016/j.applthermaleng.2019.114402
Received 26 March 2019; Received in revised form 3 August 2019; Accepted 15 September 2019
Available online 16 September 2019
1359-4311/