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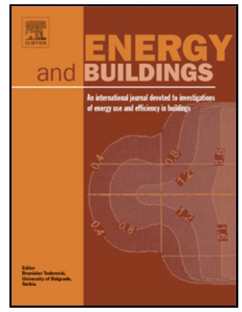

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Manufacture and multi-physical characterization of aluminum/high-density polyethylene functionally graded materials for green energy building envelope applications

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Abstract

An aluminum/High-Density Polyethylene (HDPE) functionally graded material (FGM) has been fabricated as an essential component of a multifunctional building envelope for high performance of energy efficiency and sustainability. The mass production of the FGM was realized by using coarse Aluminum (Al) particles and fine HDPE powder through a vibration-sedimentation process. The gradation of the FGM across its thickness direction was analyzed by developing a modified Rice method, from which five different uniform Al-HDPE samples were made to characterize the material properties of the five sub-layers of the FGM. The mechanical and thermal physical properties of the FGM such as Young's modulus, Poisson ratio, thermal expansion coefficients and thermal conductivities were obtained by various experimental characterizations. A prototype FGM panel with water tubes embedded was fabricated by the vibration and sedimentation combined approach and the thermal efficiency of the FGM panel was evaluated. Under an irradiation level of 620 w/m^2 and a water flowing rate of $60ml/min$, a 22.3^{o}C water temperature increase and an average 18.7^{o}C surface temperature decrease of the FGM panel were achieved, which demonstrates that significant PV conversation efficiency improvement can be realized for both electricity generation and heat collection by the presented FGM panel. The presented fabrication procedures and the associated experimental characterization methods and results can serve as a baseline for quality control of the manufacture of the green energy building envelope materials.

Key words:
Building integrated photovoltaic thermal (BIPVT); Functional graded material; Particle-size distribution; Sedimentation; Rice method;

1. Introduction

Buildings consume as much as 40% of all energy and a significant percentage of non-renewable natural resources and non-recyclable building materials [1]. In order to make dramatic improvements with regard to conserving energy and natural resources, and improving energy efficiency of buildings, it is necessary to revisit the way building envelopes are designed and manufactured. As the PV technology has advanced in recent years, integrated technologies for harvesting solar energy, such as the Building-Integrated Photovoltaic (BIPV) system, have evolved as a promising solution for meeting energy and environmental challenges [2, 3]. The building integration schemes are gaining a worldwide recognition due to the considerable savings

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