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Extended Abstract

Archives of Physics Research, 2021, 13 (1)
(https://www.scholarsresearchlibrary.com/journals/archives-of-physics-research/)

ISSN 0976-0970
CODEN (USA): APRRC7

Nano and micro-structured composite materials for privacy and smart window applications

Ibrahim Abdulhalim
Ben Gurion University, Israel
E-mail: abdulhlm@bgu.ac.il

Windows with controlled transparency are of increasing interest due to their potential energy saving and variable architectural view. These "smart windows", are a promising approach to reduce the energy consumption of buildings, which contributes up to 40% of the world's energy usage. There are several types of them, for example the ones which are voltage controlled such as the liquid crystalline based ones or the electrochromic materials usually control the transparency of the whole solar spectrum. However, thermochromic materials such as VO2 based, they block a large fraction of the sunlight on hot days, while transmitting solar energy in cold weather. Thus through temperature or voltage responsive solar energy modulation, smart windows are a key component of green buildings that have been extensively studied in the recent years. During the last few years we have been studying several concepts to improve smart window functionality both using thermochromic VO2 based nanostructures and recently based on liquid crystal line nanoporous micro-structure. In this talk we shall review our latest results along the following lines:Liquid crystalline new composite metamaterial made of nanoporous microparticles infiltrated with liquid crystal and controlled by temperature and voltage. VO2 thermochromic nano-grid films with high luminous transmittance while maintaining the solar modulation ability. The perforated VO2-based films employ orderly-patterned nano-holes, which can favorably transmit visible light dramatically but retain large solar modulation ability. SiO2/VO2 2D photonic crystals engineered for structural color tuning of reflected and transmitted light, while maintaining high solar modulation. Au/VO2 half sphere core-shell structure as a case study of the temperature-dependent plasmonic effects and the thermochromic response for smart window applicaton. By varying the Au core size, we were able to tune the transition temperature of VO2 shell. The analysis of the induced thermal strain at the Au/ VO2 interface shows that this could be the dominant reason for transition temperature reduction, contrary to the widespread view that plasmonic effects play the main role. Design rules for optimum performance of smart windows will be presented including a new approach based on deep learning.

Structural Health Monitoring (SHM) is defined as process of observing, measuring and reporting the damage and non conformities in a structure through the use of sensors within a structure. The characteristic of damage and its signature in a particular structure plays a major work in defining the architecture and the type of sensors of the required SHM system and its rest components. The present research works focuses on the relationship between various sensors and their ability to detect the damage in a material or structure's behavior. Taking into account the Current SHM approaches include applying a sensor to the outside surface of the structure or embedding some type of sensor within the composite. The sensor mounted to the outside surface of the structures used to works on varying environmental conditions, such as temperature, weather, altitude, and pressurization levels etc. These leads to false negative indication responses of the sensors for a SHM and also fail to detect internal damages. The embedded sensors at the design stage may leads to structural weakness of the material and also less capable to detect internal damages. Nanotechnology have the potential in the development of smart materials, which improves the damage detection mechanisms and hence the nano to the macro scale size damages can be detected. Glass fiber reinforced polymers (GFRP) has been embedded with Carbon Nano Fibers (CNF) in the application of composite material as structural health monitoring purpose. CNF that used to embed which should not degrade the mechanical properties of the material. Due to its piezoelectrical property, the CNF with Polyvinyl alcohol (PVA-CNF) fiber acts as a sensor in both, tensile loading -unloading and compression loading-unloading. thus, PVA-CNF sensors used as a strain sensor for the material's mechanical damage monitoring of the composite and During the mechanical tests, the structural weakness of the composite can be sensed by the electrical resistance measurement of the embedded PVA-CNF fiber sensor. The electrical conductivity of the fiber sensor on the non-conductive material

16304 P.Lakshmi and M.S.Nisha will be monitored simultaneously, to assess the potential for stress/strain and damage monitoring during the mechanical tests.

In this present work, for the structural health monitoring system, Electrical resistance measurement of the CNF fiber had been used by embedding polyvinyl alcohol-carbon nanotube fiber (PVA-CNF) sensor into the GFRP specimens at various wt% ratio with three different orientation (say 90º, 0º, 45º). The following conclusions were obtained: The conductivity in non-conductive GFRP composite materials has been detected and improved by means of PVA-CNF fiber sensor. Different specimens with embedded PVA-CNF fibers undergone various incremental tensile loading tests. It can be seen that the applied mechanical stress on the specimen were linearly change with the electrical resistance of the fiber sensor at different tensile loadings stages. The linear relation of electrical resistance on the load applied to the composite not only to find the damage accumulation. It is also possible to measure the strain state on the composite.

Bottom Note: *This work is partly presented at New Frontiers in Optics, Photonics, Lasers and Communication Systems, May 13, 2019, Tokyo, Japan*