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Editorial

Special Issues on Composite Carbon Fibers

Yong X. Gan

Department of Mechanical Engineering, California State Polytechnic University Pomona, 3801 W Temple Avenue, Pomona, CA 91768, USA; yxgan@cpp.edu; Tel.: +1-909-869-2388

The first Special Issue on "Composite Carbon Fibers" is situated in the section "Fiber Composites" in the open access *Journal of Composites Science* (ISSN 2504-477X). The objective of this Special Issue was to provide a core platform of ideas regarding basic and applied research on composite carbon fibers. A total of four publications are collected in the Special Issue, including one review article, and three original research papers. All the publications have been cited. In the following part of this editorial, a brief summary of the four publications is provided.

The first research paper [1] concerns the modulus degradation of composites containing carbon sheets and fibers under fatigue loading. The composites studied have a strong automotive industry application background. The composites reported are lightweight. In addition, the carbon sheet molding compound (C-SMC) and carbon-fiber-reinforced plastic (CFRP) have excellent strength and stiffness. The limitation of CFRP composites lies in the relatively high manufacturing costs. Therefore, as alternative composites, C-SMC carbon composite materials which are easily mass-produced have attracted great attention. This paper presents the study on the fatigue strength of both C-SMC and CFRP. From mechanical properties point of view, failure criteria for fatigue design were considered. The tensile and fatigue strengths of the C-SMC and CFRP were tested. For the C-SMC, the mechanical strength tests were conducted for two different width conditions to evaluate the cutting and the machining effects. To generate fatigue failure criteria, the stiffness drop and elastic modulus degradation were assessed for each fatigue test on the C-SMC and CFRP. The rationality of the failure criteria in terms of the stiffness drop was justified. The applicability of the fatigue life prediction of C-SMC based on the elastic modulus degradation was also confirmed.

In the second research paper, the electrical and photonic properties of cobalt oxide-containing composite carbon fibers were tested [2]. During processing, cobalt acetate and polyacrylonitrile (PAN) polymer were co-electrospun into nanofibers. Following that, oxidization and pyrolysis were performed to obtain PAN-derived composite carbon fibers containing cobalt oxide. The electrical and photonic properties of the composite fibers under visible light illumination were measured to assess the photoelectric energy conversion behavior of the composite fibers. The p-type semiconducting behavior of the composite fiber was shown by measuring the open circuit voltage of a photochemical fuel cell consisting of the photosensitive electrode made from the composite fiber. The application of the composite fiber for glucose sensing was also demonstrated

The third research paper is on recycling woven carbon fiber fabric waste to manufacture high performance aligned discontinuous fiber composites [3]. As is known, waste management is a serious issue in sustainability. Composite manufacturing and applications produce a large amount of waste. The waste could be in various forms, such as composite by-products from the production and out-of-service end products. This paper focused on the remanufacturing of dry fiber off-cuts, produced during the composite fabric weaving process, into highly aligned discontinuous prepreg tapes with high-performance discontinuous fiber (HiPerDiF) technology. Unidirectional laminate specimens were prepared using various combinations of fiber lengths and tested under tensile loadings. The stiffness of the

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remanufactured composite is 80 GPa, and the strength is 800 MPa. The, strain-to-failure rate is 1%. Several applications including adhesive film, feedstock for filament winding, and tow for weaved fabrics were proposed for the produced tapes. This research illustrated the value of recycling carbon fiber composites waste.

In the review article [4], the advances in manufacturing composite carbon nanofiber aerogels were detailed. The manufacture of composite carbon nanofiber-based aerogels with freeze casting technology was demonstrated. Freeze casting is a relatively new manufacturing technique for generating highly porous structures. During the process, deep cooling is used first to rapidly solidify a well-dispersed slurry. Then, vacuum drying is conducted to sublimate the solvent. This allows for the creation of highly porous materials. Although the freeze casting technique was initially developed for porous ceramics processing, it has found various applications, especially for making aerogels. Aerogels are highly porous materials with an extremely high volume of free spaces, which contributes to the characteristics of high porosity, ultralight, a large specific surface area and interface area, and in addition, very low thermal conductivity. Recently, carbon nanofiber aerogels were studied to achieve exceptional properties of high stiffness, being flame-retardant and thermal-insulating. The freeze casting technology was reported for preparing carbon nanofiber composite aerogels for energy storage, energy conversion, water purification, catalysis, fire prevention, etc. This review explores freeze casting carbon nanofiber composite materials consisting of functional nanoparticles with exceptional properties. The content of this review article is organized into four major parts. The first part introduces the general freeze casting manufacturing technology of aerogels with an emphasis on how to use the technology to make nanoparticle-containing composite carbon nanofiber aerogels. Then, modeling and characterization of the freeze cast particle-containing carbon nanofibers is presented with an emphasis on modeling the thermal conductivity and electrical conductivity of the carbon nanofiber network aerogels. After that, the applications of the carbon nanofiber aerogels are described. Examples of energy converters, supercapacitors, secondary battery electrodes, dye absorbents, sensors, and catalysts made from composite carbon nanofiber aerogels are shown. Finally, the perspectives for future work are presented.

The second Special Issue on "Composite Carbon Fibers, Volume II" is still open for submissions. Currently, two research papers are available in this issue. Both papers have been cited. The following abstract excerpts with some modifications outline the contents of the two papers. In the first paper, the bonded composite hose (MBCH) and its helix reinforcement were shown [5]. This research has a strong application background in the petroleum industry. With the exploration for oil trending to deeper levels, from shallow waters to deep waters, there is a corresponding increase in the need for more sustainable conduit materials for production purposes. Secondly, there is an increasing demand for more energy from fossil fuels that are excavated with less expensive technologies. As such, short-service hoses are applied in the offshore industry. The industry utilizes composites to improve the material and solve different offshore issues. This work analyzed a problem currently facing the oil and gas industry regarding hose usage. The results from the local design and analyses of a marine bonded composite hose (MBCH) were presented. The local design of a 1 m section of an MBCH was carried out in ANSYS under different loading conditions. Design criteria and load conditions were set to simulate the model using the finite element method (FEM). The composites were considered to improve conventional marine hoses. Linear wrinkling and damage sites on the helix reinforcement were identified. Experimental investigation and proper content tests are recommended for the bonded hose. Reinforced hoses were recommended at the ends of the MBCH, as maximum stresses and strains occurred at these locations. It is recommended that hose operations such as reeling be conducted under operational pressure and not design pressure, as the study shows that the design pressure could be high on the hose model.

In the second paper of this issue [6], preparation of a functional composite carbon fiber with a large surface area for spilled oil cleaning was performed. The composite fiber consisted of photosensitive oxide particles and polymer-derived carbon. It was made by co-spinning the polymer and metallic salts. After heat treatment at high temperatures, activated carbon fibers containing oxide particles ware obtained. The particles were found to be distributed in the fibers and at the surface of the fibers. The composite fibers were found sensitive to sunlight. Fiber mats made of the composite fibers possessed a high surface area for oil absorption and removal. Cobalt(II) titanate particles were obtained from the reaction of titanium dioxide and cobalt oxide at elevated temperatures. The reaction occurred in situ through the hydrolysis of metallic compounds in the spun fiber and the subsequent sintering. The titanium dioxide and cobalt(II) titanate particle-containing fibers demonstrated strong photoactivity in the visible light spectrum range. It was concluded that particle-containing composite carbon fiber mats can be prepared successfully by co-electrospinning followed by sintering. Due to the oleophilic properties and the high active surface area, the composites are suitable for spilled oil cleaning owing to their fast absorption.

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