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Distributed collaborative reliability optimization for mechanical dynamic assembly relationship with support vector machine regression

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Mechanical dynamic assembly relationship seriously influences the reliability and work efficiency of complex machinery. To design a more reasonable mechanical dynamic assembly relationship involving multiply objects and multiply disciplines, a novel optimization method (called as SR-DCRSM) and a optimization model (multilayer model) are proposed for mechanical dynamic assembly reliability optimal design. The SR-DCRSM is developed by integrating Support Vector Machine Regression (SR) and Distributed Collaborative Response Surface Method (DCRSM). To validate the proposed approach and model, the reliability optimal design of gas turbine high pressure turbine Blade-Tip Radial Running Clearance (BTRRC), as a representative mechanical dynamic assembly relationship, was completed by considering nonlinear material parameters and dynamic heat load and mechanical load. The optimization results demonstrate that all optimal solutions satisfy the requirements of reliability optimal design of BTRRC and assembly objects, and the optimized BTTRC deformation is reduced by 10% approximately, which are promising to improve BTRRC design and control. As shown in the comparison of methods and model, the presented SR-DCRSM holds higher computational efficiency and precision, and the multilayer model possesses higher precision for mechanical dynamic assembly reliability optimal design. The presented efforts not only improve the performance and reliability of gas turbine, but also provide a promising approach and a valuable optimization model for mechanical dynamic assembly reliability optimal design. Besides, the present works enrich mechanical reliability design theory and method.

Polymer-free mechanically robust carbon fiber foams

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Polymer-free mechanically robust mats of intertwined nanofibers of pure carbon were grown using the Constrained Formation of Fibrous Nanostructures process. Characterization of the microstructure, mechanical and electrical properties of the low density foam-like samples confirmed the uniqueness of the material. It is formed entirely of independent fibers of diverse diameters that interlock forming a tridimensional body that when subject to cyclic compressive loads shows a linear correlation between strain and electrical resistivity. Moreover, the fibrous product regains its shape after loads are removed, presenting a viscoelastic behavior, is light weight, thermally stable up to 550 °C, hydrophobic and electrically conductive. The potential of the foams as energy absorbers was tested in the bare material and on CFF hybrids. For the later, IFWS2 nano particulates, well known shock absorbers, and non-Newtonian fluids were embedded into the fiber microstructure. Earlier reported strategies to develop tridimensional structures using carbon nanotubes or carbon fibers are quite complex, difficult to reproduce or expensive, and most of them involve a polymeric component. Control over the nano-fiber or nano-tube based 3D macroscopic object geometry, density, and means to create an interface with other components has turned to be a titanic effort. Here, we present a process by which the Carbon Fiber Foam (CFF) can be grown into different shapes and sizes at moderate temperatures, opening a wide window of possible applications. Challenges found when scaling up the fabrication process and routes to address them will be presented.

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