Simulating Impact Properties Of CF/PPS Composites Using COMSOL Multiphysics®.

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Abstract

This research explores the impact properties of Carbon Fiber Reinforced Polyphenylene Sulfide (CF/PPS) thermoplastic composites, particularly focusing on how these properties change with temperature. The study utilizes the advanced capabilities of COMSOL Multiphysics® software to simulate and analyze these variations under different conditions. The simulation begins with creating a detailed three-dimensional model of the CF/PPS composite within COMSOL Multiphysics®. The model is designed to accurately reflect the material's characteristics, including density, Young's modulus, Poisson's ratio, and thermal conductivity. The simulation setup replicates the impact testing environment, factoring in critical parameters such as the speed and angle of the impactor and the temperature during impact. The boundary and initial conditions are carefully defined to match real-world experimental setups, ensuring that the simulation results are both precise and relevant.

The research is expected to demonstrate how the impact properties of Carbon Fiber Reinforced Polyphenylene Sulfide (CF/PPS) composites, such as break energy and impact strength, vary with temperature changes. Detailed stress and deformation patterns within the composite during impact will be identified using the Structural Mechanics Module, highlighting critical stress points and potential failure modes. Thermal distribution analysis, facilitated by the Heat Transfer Module, will provide insights into how temperature affects the material's performance and durability. LiveLink™ for MATLAB® is integrated into the workflow to facilitate post-processing and analysis. Custom MATLAB® scripts are developed to automate the extraction and analysis of key parameters, such as break energy and impact strength, from the simulation data. This integration significantly improves the efficiency and comprehensiveness of the analysis process. Models related to composite material analysis and impact testing are customized to incorporate the specific material properties and boundary conditions relevant to CF/PPS composites.

The Application Builder is used to create a custom user interface for the simulation model. This interface simplifies the process of setting up and running simulations for various impact scenarios and temperatures, making it more accessible to researchers who may not be experts in using COMSOL Multiphysics®. This research effectively demonstrates the use of COMSOL Multiphysics® and its add-on modules in simulating and analyzing the impact properties of Carbon Fiber Reinforced PPS thermoplastic composites. By integrating tools such as LiveLink™ for MATLAB®, the Application Builder, COMSOL Compiler™, and COMSOL Server™, the study offers a comprehensive and user-friendly approach to understanding the temperature-dependent variations in impact properties. Overall, the results will provide valuable insights into the impact behavior of CF/PPS composites and contribute to developing more durable composite materials for aerospace and automotive applications.

Keywords: thermoplastic ,thermal, impact , temperature, simulation.