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Influence of Low and Extreme Heat Fluxes on Thermal Degradation of Carbon Fibre-Reinforced Polymers

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Abstract : This study considers the influence of different irradiation scenarios on the thermal degradation of carbon fiber-reinforced polymers (CFRP). Real threats are simulated, such as fires with long-lasting low heat fluxes and nuclear heat flashes with short-lasting high heat fluxes. For this purpose, coated and uncoated quasi-isotropic samples of the commercially available CFRP HexPly® 8552/IM7 are thermally irradiated from one side by a cone calorimeter and a xenon short-arc lamp with heat fluxes between 5 and 175 W/cm² at varying time intervals. The specimen temperature is recorded on the front and backside as well as at different laminate depths. The CFRP is non-destructively tested with ultrasonic testing, infrared spectroscopy (ATR-FTIR), scanning electron microscopy (SEM), and micro-focused computed X-Ray tomography (µCT). Destructive tests are performed to evaluate the mechanical properties in terms of interlaminar shear strength (ILSS), compressive and tensile strength. The irradiation scenarios vary significantly in heat flux and exposure time. Thus, different heating rates, radiation effects, and temperature distributions occur. This leads to unequal decomposition processes, which affect the sensitivity of the strength type and damage behaviour of the specimens. However, with the use of surface coatings, thermal degradation of composite materials can be delayed.

Keywords : CFRP, one-sided thermal damage, high heat flux, heating rate, non-destructive and destructive testing
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