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X-ray Computer Tomography and Real Time Ultrasonic Inspection as Process Development Tools for Discontinuous Fiber Composites

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Abstract

X-ray Computer Tomography (XCT) and Real Time Ultrasonic Inspection (RTUIS) has been used to analyze fiber orientation and flow patterns in both discontinuous long- fiber thermoset composites and in long-fiber injection molded composites. X-ray computed tomography (XCT) is a non-destructive technique that may be used to provide structural information within an object by mathematically reconstructing its 3-D image from a series of projections, providing the ability to make quantitative measurement on complex structures. Material quantity and size limitations are generally eliminated (up to the limits of the XCT size) and the images may be taken at any required section of the sample with no extensive pre-imaging sample preparation. The Real Time Ultrasonic Imaging System (RTUIS) developed at PNNL uses a liquid surface ultrasonic detector that produces an instantaneous two-dimensional image. Images are formed in 100-μs and are displayed at video frame rates (60 images per second). At any instant a 3-inch diameter field-of-view is presented. Using 5-MHz ultrasound, the field displays 5,625 resolvable picture elements instantaneously.

Over the past two years, PNNL has developed the XCT and RTUIS techniques specifically applicable to long-fiber injection molded thermoplastics and random long-fiber thermoset molded composites. These techniques provide a basis for optimizing process parameters and fiber orientations and in this paper, examples of the techniques in practice will be provided on both injection molded and compression molded parts.