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Acoustic Emission Monitoring of Unstable Damage Growth in Carbon-Fiber-Reinforced Polymer Composites under Tension

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The catastrophic final failure of CFRP composite materials has been observed to originate when clusters of 0º fibers start failing. The study seeks to identify such mechanism as a reliable predictor of the impending failure. Currently available sensors were found to be inadequate for distinguishing acoustic emission (AE) signals corresponding to different failure modes. A modified sensor capable of accurately measuring frequencies to 2 MHz was developed, validated and instrumented on carbon/epoxy coupons. The improved fidelity to high frequency components provided the opportunity to distinguish fiber break related events which have relatively high frequency components and strong presence of symmetric Lamb waves, due to the small area involved and in-plane nature of the damage mode, respectively. A correlation technique was developed to extract groups of fiber break related AE signals that correlated with each other in order to identify clusters of fiber breaks. The signals within such groups are found to have frequencies in excess of 1 MHz. After the appearance of such groups, the subsequent rapid increase in the number and size of such groups was found to coincide with the final failure of the specimen. This observation is more consistent with the progression of unstable damage growth than traditional AE techniques due to significant variation in the predictors used in the latter for tests from even nominally identical specimens.