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Uncertain Mechanical Properties of Nanocomposite Materials

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Summary

Our systematic property characterizations of nanocomposites have shown that there was a very small increase (sometimes even decrease) of tensile strengths and fracture toughnesses. A major reason is that very strong nanotube/nanofibers inside nanocomposites are not fully loaded due to low efficient interfacial shear transferring. More importantly, our previous experiments indicate that there is always a large scatter in the strength data of nanocomposites. This phenomenon results from several special features of nanocomposites 1) the high mismatch in elastic properties of the matrix material and the nanoscale reinforcement; 2) large interfacial bonding area of nanocomposites compared to the same traditional composites with the same fiber/particle volume percents; and 3) nanofiller agglomeration phenomenon. The first factor will lead to early interfacial debonding between the matrix and the nanotube/nanofiber end, compared to traditional composites with less stiffness mismatch. The second aspect can be used to explain that interfacial defects are easily induced in nanocomposites than traditional composites, and cause a large scatter in nanocomposite failure strengths. In this study, we will correlate the failure strengths with interfacial defects of nanocomposites using Monte-Carlo simulations and interfacial fracture mechanics theory. We will also validate these simulations using tensile experiments on nanocomposite specimens.