A Model for Toughening of Semicrystalline Polymers

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ABSTRACT: Dispersing particles within a semicrystalline polymer can result in remarkable impact strength improvement and opens promising routes toward super-tough materials. Although the technique is extensively employed to modify polymer properties, predicting which dispersions yield toughness remains a challenging issue. By comparing the characteristic lengths and deformation processes involved in toughening, we explain why a minimum matrix confinement or ligament thickness is required to induce ductility. Our model was used to interpret experimental data and show how this critical confinement length depends on material properties, temperature, and processing history. Most importantly, it reveals an unexpected particle size effect. The predictions provide fresh insight into the design of toughened materials. The model also provides guidance to understanding the fracture mechanics of other complex systems such as composites or biological matter.