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Phase Dependent Fracture and Damage Evolution of Polytetrafluoroethylene (PTFE)

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Compared with other polymers, polytetrafluoroethylene (PTFE) presents several advantages for load-bearing structural components including higher strength at elevated temperatures and higher toughness at lowered temperatures. Failure sensitive applications of PTFE include surgical implants, aerospace components, and chemical barriers. Polytetrafluoroethylene is semi-crystalline in nature with their linear chains forming complicated phases near room temperature and ambient pressure. The presence of three unique phases near room temperature implies that failure during standard operating conditions may be strongly dependent on the phase. This paper presents a comprehensive and systematic study of fracture and damage evolution in PTFE to elicit the effects of temperature-induced phase on fracture mechanisms. The fracture behavior of PTFE is observed to undergo transitions from brittle-fracture below 19°C to ductile-fracture with crazing and some stable crack growth to plastic flow aver 30°C. The bulk failure properties are correlated to failure mechanisms through fractography and analysis of the crystalline structure.

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