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Thickness Dependence of Failure in Ultra-thin Glassy Polymer Films[1] REED BAY, SHINICHIRO SHIMOMURA , Univ of Mass - Amherst, YUJIE LIU, Arkema Inc., MARK ILTON, ALFRED CROSBY, Univ of Mass - Amherst — The physical properties of polymer thin films change as the polymer chains become confined. Similar changes in mechanical properties have been observed, though these critical properties have only been explored a limited extent and with indirect methods. Here, we use a recently developed method to measure the complete uniaxial stress strain relationship of polymer thin films of polystyrene films (PS, Mw=130kg/mol, 490kg/mol, and 853kg/mol) as a function of thickness (20 nm-220nm). In this method, we hold a 'dog-bone' shaped film on water between a flexible cantilever and a movable rigid boundary, measuring force-displacement from the cantilever deflection. From our measurements, we find that the modulus decreases as the PS chains become confined. The PS thin films exhibit "ideal perfectly plastic" behavior due to crazing, which differs from the typical brittle response of bulk PS. The draw stress due to crazing decreases with film thickness. These results provide new fundamental insight into how polymer behavior is altered due to structural changes in the entangled polymer network upon confinement.

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