MECHANICAL ENGINEERING MSc SEMINAR (30 min.)

Thursday, September 10, 2026 at 13:30, Lady Davis Building, Auditorium 250

Yield Surface Determination via Combined Tension-Torsion Loading of Ultem 1000

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High-performance amorphous polymers, such as Polyetherimide (PEI / Ultem 1000), are increasingly vital in demanding aerospace and structural mechanical applications. However, predicting their plastic failure under multiaxial stress states remains a critical design challenge, as classical metal-based criteria fail to capture their inherent pressure sensitivity, tension-compression asymmetry, and time-dependent viscoelasticity. This seminar presents an integrated experimental-numerical framework developed to systematically probe and map the multiaxial yield behavior of Ultem 1000 under combined tension, compression, and torsion. To eliminate geometry-induced bias and maintain a uniform plane-stress state, a single thin-walled hollow cylindrical specimen was used for all loading paths. A key highlight of this methodology is the development of a high-fidelity 3D finite element model in ANSYS. By validating numerical torque-rotation responses against experimental data, a precise kinematic conversion was established to isolate local gauge deformation from global grip measurements, successfully functioning as a virtual strain probe without auxiliary physical instrumentation. Following methodology validation using a classically symmetric Aluminum 6061-T6 benchmark, the initial and subsequent yield behavior of Ultem 1000 was systematically characterized. The research specifically addresses the challenge of identifying plastic onset under highly restricted deformation scales, where preloads and time-dependent viscoelastic creep distort strain measurements. A systematic separation methodology was developed to decouple true plastic strain from viscoelastic effects. The resulting experimental yield points are compared against pressure-sensitive criteria from the literature, and the progressive, shape-preserving expansion of subsequent yield surfaces is discussed. These findings provide a vital empirical foundation for advanced predictive simulations of polymeric components in modern engineering design.

Seminars Coordinator: Prof. Sefi Givli