MECHANICAL ENGINEERING SEMINAR

Monday, November 16, 2026, at 14:30, D. Dan & Betty Kahn Building, Auditorium 1
Online: Zoom link

From reconfigurable metamaterials to hierarchically smart architected matter

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Hosted by: Prof. Alon Wolf

Multistable metamaterials are engineered structures capable of reconfiguring between distinct equilibrium states, offering extraordinary functionality, such as substantial energy dissipation and nonlinear wave propagation. However, current implementations rely predominantly on macroscale, polymer-based fabrication, resulting in architectures suffering from geometric defects, wave attenuation, and limited scalability. Transitioning to silicon-based microfabrication provides a scalable route to realize low-loss, nearly defect-free reconfigurable metamaterials, overcoming these limitations. Yet, this approach entails new challenges in operation, wave generation, and testing at the microscale.

To address these challenges, this talk will present a framework for multistable reconfigurable metamaterials on a chip, encompassing their realization, actuation, and characterization across quasistatic and dynamic regimes. First, I will present the microfabrication of bistable micro-elements and their assembly into wafer-level, silicon-based chains with unprecedented numbers of unit cells. Next, I will introduce a novel *in-situ* method for measuring the non-monotonic force-displacement relation characteristic of bistable elements – directly at the microscale. Finally, I will address the critical bottleneck of triggering nonlinear transition waves in micro-architectures, enabling their first experimental investigation at small scales and in a silicon medium. This breakthrough unlocks tailored wave control through design, and particularly, complex, non-constant wavefront velocity profiles achieved by engineering aperiodic, functionally graded architectures.

Ultimately, this framework provides a controlled testbed for experimental nonlinear dynamics, enables on-chip mechanical signal manipulation, and paves the way for the integration of metamaterials with microelectromechanical systems (MEMS). I will conclude by sharing my vision and future opportunities for hierarchically smart architected matter across length scales.

Emil Bronstein is a postdoctoral researcher in the Department of Mechanical and Process Engineering at ETH Zürich with Prof. Dennis M. Kochmann. His current work focuses on designing and microfabricating reconfigurable mechanical metamaterials and developing experimental methods to study their quasistatic and dynamic behavior. He completed his B.Sc., M.Sc., and Ph.D. in Mechanical Engineering at the Technion, where he investigated the microstructure underlying the martensitic phase transformation in shape memory alloys, as well as the transient, small-scale avalanches governing macroscopic deformation in ferromagnetic materials and conventional metals, such as magnesium.
Emil is the recipient of several honors, including the Rothschild Postdoctoral Fellowship, Azrieli Graduate Studies Fellowship, Daniel Excellence Fellowship, Pnueli and Altus awards for excellent Ph.D. and M.Sc. theses, respectively, the Jacobs Award for an Excellent Publication, and 8 awards for Excellence in Teaching.

Seminars Coordinator: Prof. Sefi Givli