
3D Wrinkled Substrates for Soft Pressure Sensing: Maximizing Surface Area and Mechanical Resilience

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Abstract

This study explores the enhancement of surface area in three-dimensional wrinkles within multi-layered systems, with applications in soft pressure sensors. Embedding pressure sensors in a wrinkled substrate significantly increases their sensitivity and mechanical robustness. Despite these advantages, systematic investigations into methods for enlarging the wrinkle surface area in layered systems remain limited. Utilizing a morphoelastic plate theory framework, we analyze the formation and behavior of 3D wrinkles in fiber-reinforced multi-layered substrates. Both linear stability analysis and post-bifurcation analysis are conducted to comprehensively understand wrinkle development. Our research examines the influence of matrix and fiber properties on the wrinkle surface area, offering valuable insights for the design of ultra-sensitive and mechanically resilient pressure sensors.

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