Detaching a sphere from an elastic nanofilm: Experiments and multiscale theories

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Abstract

In the presence of adhesion, separating two objects in contact requires overcoming a finite detachment force. In this talk, I will discuss experiments and theory for the detachment force between a rigid sphere and a tensioned elastic sheet from polymeric to graphene sheets. I will show that the detachment force can increase with the tension applied to the sheet, which cannot be explained by existing adhesion theories. This increase manifests itself when the deformation of the sheet during detachment is constrained to the atomic level by the applied tension. We then develop a multiscale adhesion theory by considering intermolecular forces that are often overlooked at the macroscopic level, elucidating our findings consistently. This work points to a generic strategy to understand the adhesion of slender structures across various length scales and also provides important implications for cell mechanics and micro/nano-electromechanical systems (M/NEMS).

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