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Validation of Wrinkling-to-Delamination Adhesion Measurement Technique

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ABSTRACT

Polymer thin films have a wide range of applications that span several different industries. Their optical clarity as well as their mechanical rigidness result in their versatile use in applications such as contact lenses, wearable sensors, and flexible electronics. These applications require precise adhesion, so the need for a simple, quantitative adhesion measurement technique is critical. Several methods have already been developed that quantify the adhesion of flexible thin films attached to rigid substrates. However, when the thin films are rigid and the substrates compliant, these methods are insufficient. In the authors' previous work, an adhesion measurement technique was developed that took advantage of well-characterized surface buckling instabilities that formed when the system was placed in lateral compressive strain, exploiting the wrinkling to delamination transition that occurred. This technique was proven to work for a narrow range of materials. Therefore, the focus of this paper was to validate this wrinkling to delamination adhesion measurement technique by utilizing a variety of film-substrate systems with varying surface energies and substrate moduli. In the authors' previous work, the technique was validated using polystyrene (PS) and poly(methyl methacrylate) (PMMA) as high surface energy polymer thin films and poly(dimethyl siloxane) (PDMS) as a low surface energy substrate. In this work, Teflon AF 1600, a polytetrafluoroethylene copolymer, was utilized as a low surface energy thin film and bovine gelatin as a high surface energy substrate to determine the limitations of this adhesion technique.

KEYWORDS

adhesion, surface buckling, polymer thin film, surface energy