Damage quantification of thin films on soft substrate

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Abstract

Thin films on soft substrates are a subject of interest in several applications such as cosmetics and flexible electronics (OLED). Understanding damage to the film or debonding from the substrate can be crucial for the functionality, aesthetics, and lifetime of such films. However, understanding remains limited due to the large deformation of the soft substrate compared to investigations for rigid substrates(1), evidence of mixed-mode interfacial fracture and sliding at the interface(2), and due to the inelastic behavior of the film. We show a robust methodology to characterize damage and adhesion and more generally, the durability of thin films on a soft substrate. Results can then be extended to different substrates. The method involves macroscopic mechanical measurements and simultaneous local optical imaging using camera and confocal microscopy to characterize the different features of the deformed film and the mechanisms by which thin coatings accumulate damage due to the stretching of the substrate. After extracting the local deformation field in both the film and at the interface (3) (using fluorescent markers embedded near the surface of the substrate), we derive suitable PIV algorithms to extract local deformation mismatches due to phenomena such as fracture, debonding, slippage and plasticity. Combining with energy modelling, these quantifications can be used to obtain the desired interfacial adhesion and cohesive energy of the film.

References

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