Measurement of adhesion between soft elastomers
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ABSTRACT
The JKR (Johnson–Kendall–Roberts) method is widely used to measure the work of adhesion between soft materials. In this article, the JKR theory is summarized and three-dimensionless parameters are proposed to design a proper JKR experiment. The study of adhesion between two commonly used soft elastomers PDMS (Sylgard 184) and Ecoflex 0300 are obtained with the measured pull-in and pull-off forces from a dynamical mechanical analyzer. The effect of base-polymer-to-curing-agent mixing ratio, i.e., crosslinking density, and solvent extraction are examined. It is found that the pull-in adhesion stays more or less constant for all contact pairs we measured. Although the effect of crosslinking density is not significant for pristine PDMS, it is very obvious that the higher self-adhesion can be found in less crosslinked PDMS after solvent extraction. Such an effect is even more drastic for PDMS-to-Ecoflex adhesion. An adhesion mechanism is proposed to explain these complex adhesion behaviors. It is concluded that the entanglement and interpenetration of tethered chains could enhance the pull-off work of adhesion, whereas those of free chains cannot. As a byproduct of the JKR experiment, Young’s moduli of PDMS of different mixing ratios are also obtained by a two point formula and the results are comparable with those obtained by standard tensile tests.