Electronic supplementary material

Self-folding mechanics of graphene tearing and peeling from a substrate

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1 Self-folding graphene on a substrate

Due to its ultra-thin thickness as well as interlayer interaction, graphene can easily fold under external stimuli and exhibits self-folding [1-3]. In fact, the height of folding ridge that stories the bending energy is also affected by the adhesion energy of the substrate. As shown in Fig. S1. The height of monolayer graphene is obviously impacted by the adhesion strength compared with that of bilayer graphene. The height of monolayer graphene as a function of adhesion strength can be fitted by using the function form $h = d + A/[1 + B(\gamma_1/\gamma_2)^n]$, where d = 3.4 Å, A = 5.86 Å, B=0.494, n = 0.789. The height of bilayer graphene as a function of adhesion strength is almost a constant, $h \approx 15.17$ Å. As a result, the elastic energy of monolayer graphene should include the influence of adhesion strength, while this effect of bilayer graphene can be neglected.

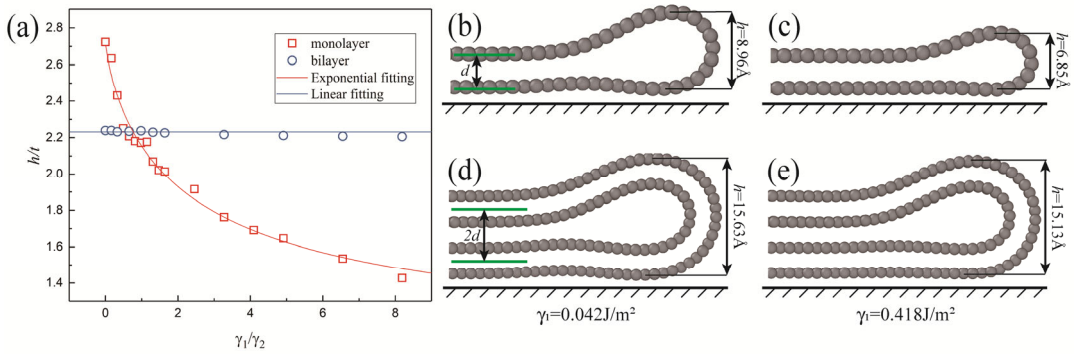

Fig. S1 Self-folding of graphene on a substrate. **(a)** The ratio between the height h of folding ridge and thickness t as a function of the ratio of adhesion strength between graphene to substrate and graphene to itself. **(b-e)** showing the cross sections of self-folding graphene on the substrate. (b, c) monolayer graphene. The interlayer distance d = 3.4Å. (d, e) bilayer graphene. The equivalent interlayer distance $2d$ = 6.8 Å.

2 Tearing monolayer graphene without substrate

In Ref. [4], Bayart *et al.* demonstrated that the crack trajectory in the peel-like configuration follows a power law with an exponent 3/4. A more detailed analysis revealed that because of the folding ridge of thin film possessing the characteristics of a Lobkovsky-Witten ridge when the flap is pulled with peeling angle close to π, the crack trajectory can be described by a power law with an exponent 8/11 [5]. In our MD simulation, the crack path of tearing monolayer graphene without substrate also follows a power law with an exponent 0.789, which is close

to above experiment and theoretical analysis but slightly higher. This can be attributed to graphene interlayer interaction, which influences the competition between elastic fracture energies, as indicated by Eq. (7).

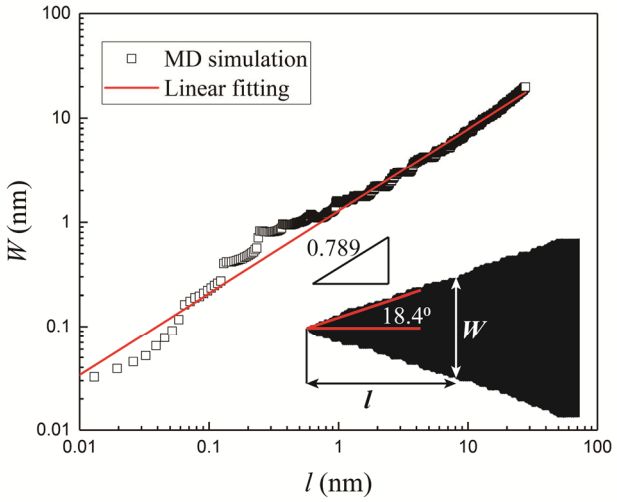

Fig. S2 The shape of a torn flap obtained by tearing monolayer graphene without substrate. The taper angle is obtain by fitting a linear relationship of $W \sim l$.

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