Electronic Supplementary Information for

Kirigami Enhances Film Adhesion

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Captions for Supplementary Movies S1 to S7

Other Supplementary Information for this manuscript include the following:

Supplementary Movies S1 to S7

Supplementary Information Figures and Figure Captions

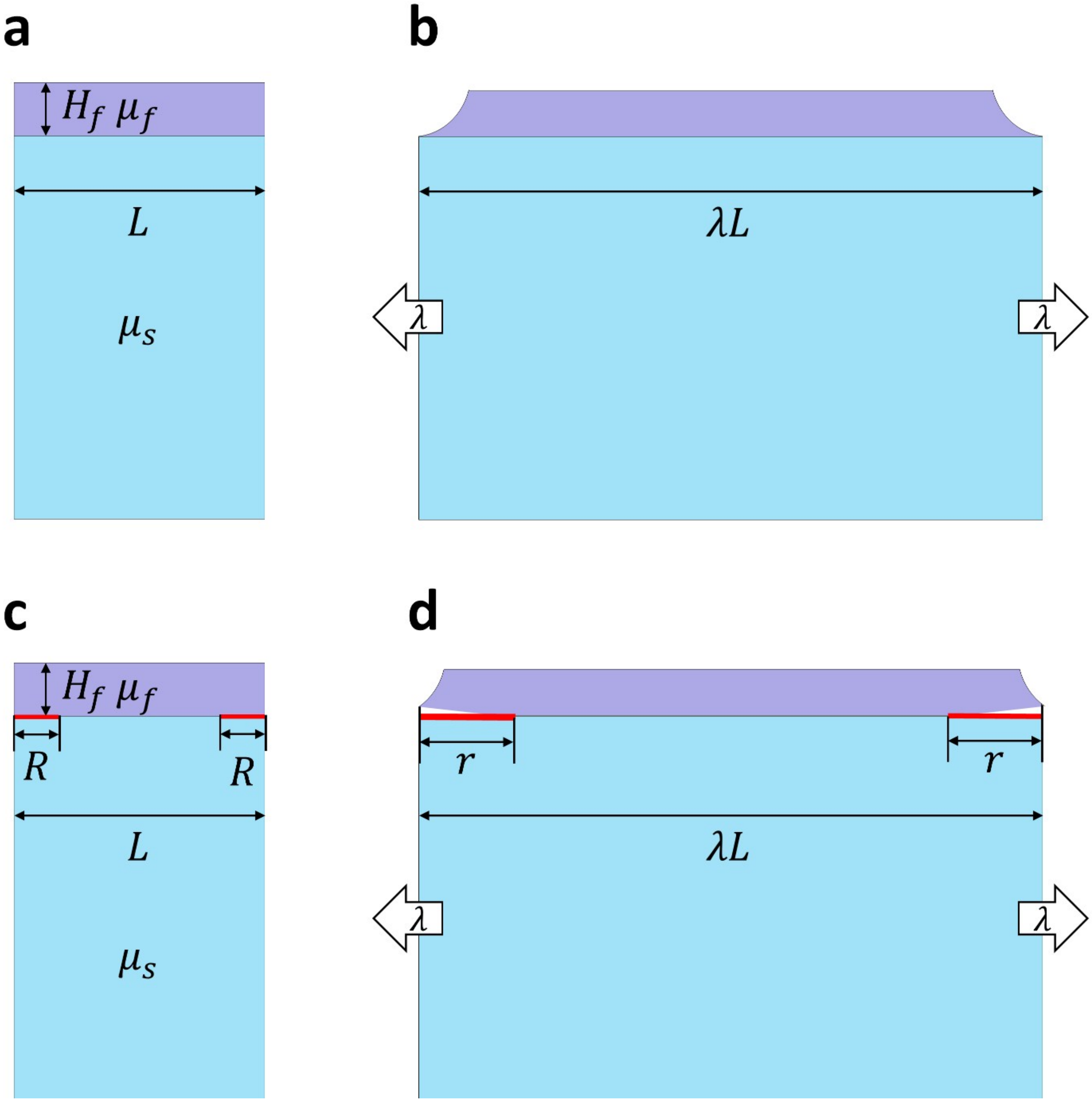

Fig. S1. Modeling of film-substrate system for calculation of energy release rate for crack initiation. a) Undeformed state. b) Shear-lag effect in film when the substrate is under applied stretch λ. c) Undeformed state with prescribed edge cracks length R. d) Substrate under applied stretch λ and cracks are stretched to length r. The energy release rate at applied stretch λ is calculated as the energy difference between d) and b), divided by the crack length R.

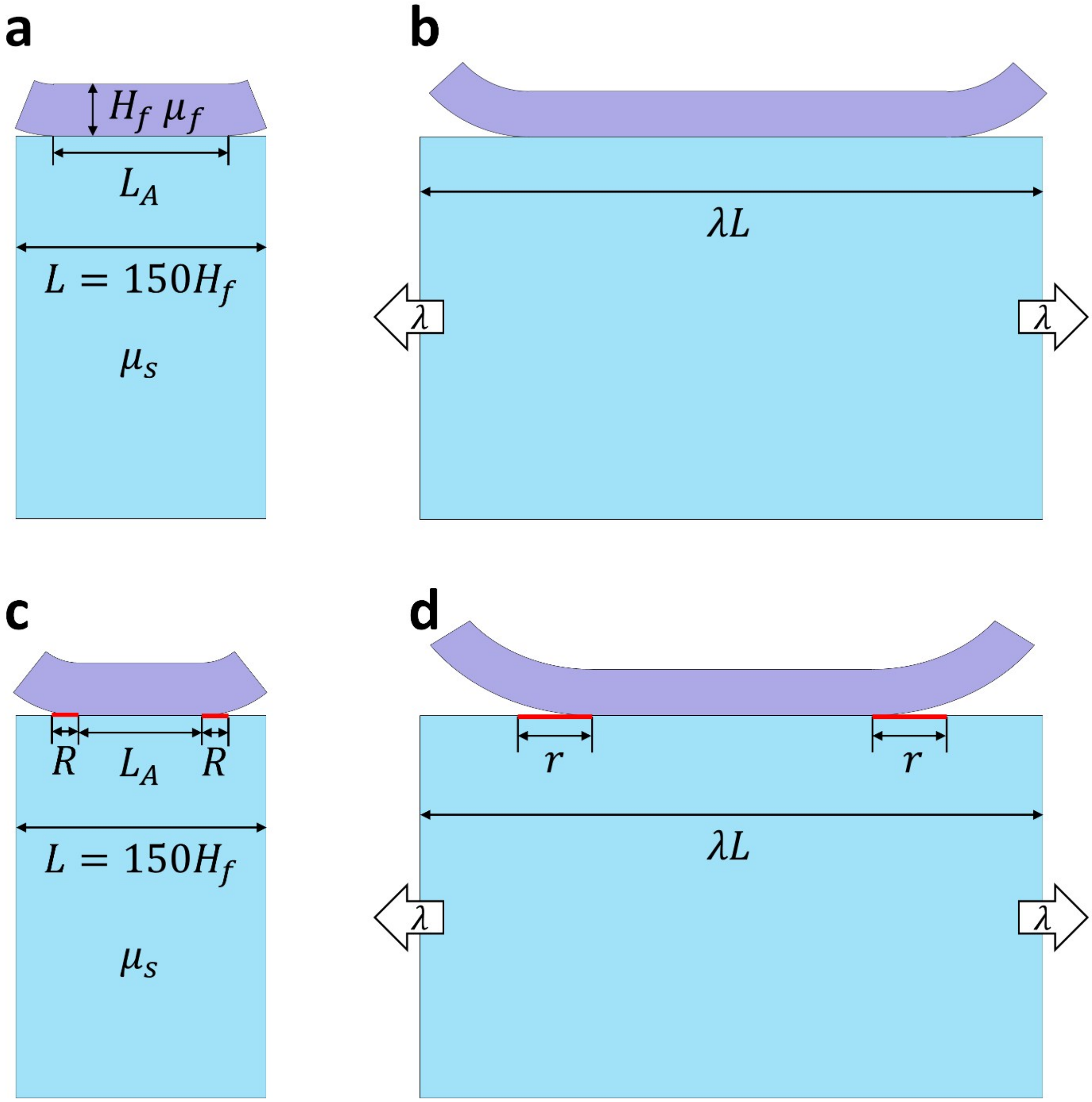

Fig. S2 | Modeling of film-substrate system for calculation of energy release rate for crack propagation. a) Undeformed state with film edges partially detached from substrate. b) Substrate is under applied stretch λ. c) Undeformed state with further induced cracks length R. d) Substrate under applied stretch λ and the induced cracks are stretched from length R to r. The energy release rate at applied stretch λ is calculated as the energy difference between d) and b), divided by the crack length R.

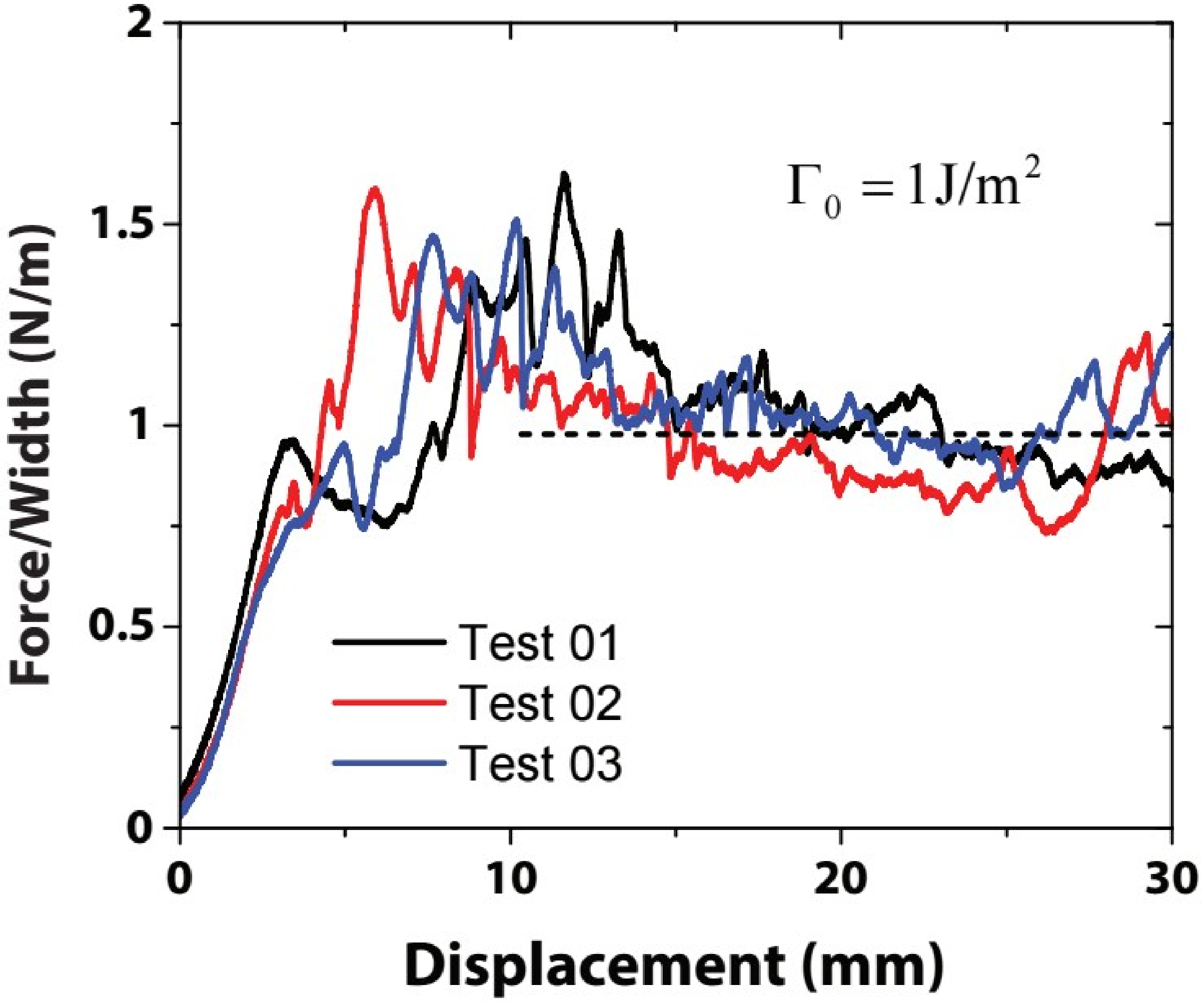

Fig. S3. Interfacial toughness measurement of the PDMS/Ecoflex interface with 90-degree peeling test. The plateau value of force per width of the sample gives the interfacial toughness.

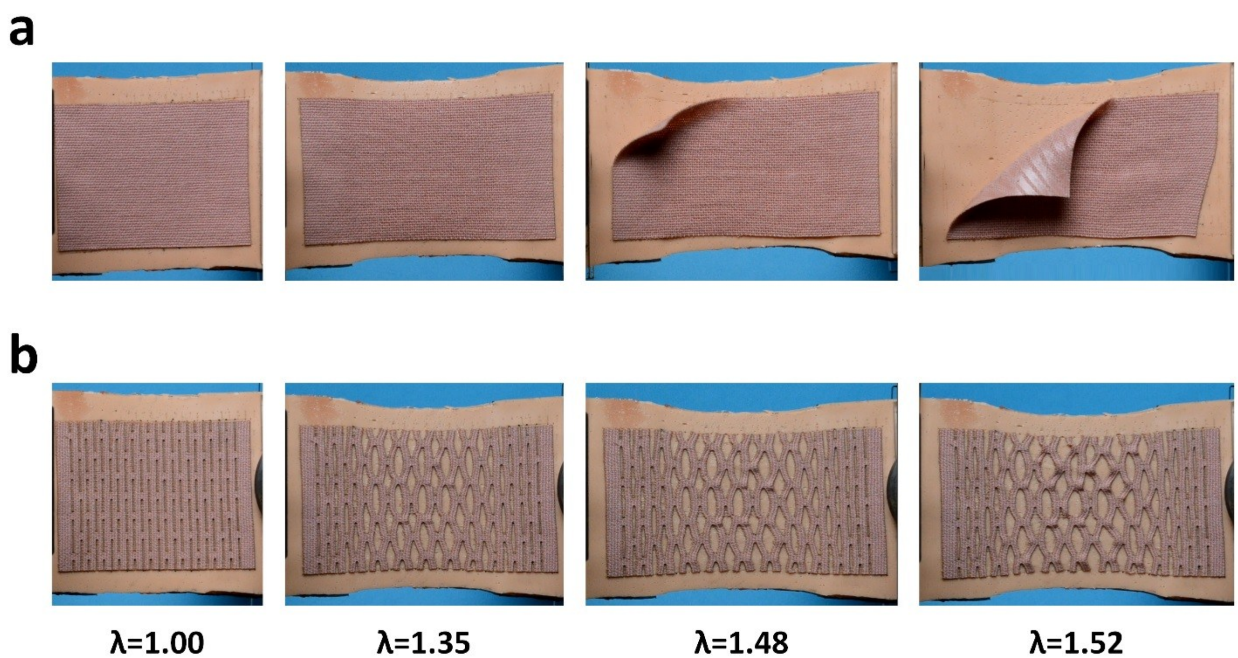

Fig. S4. Medical bandages (3M™ Elastic Adhesive Bandage) on substrates undergoing inhomogeneous deformation. a) The continuous bandage delaminates under moderate stretch. b) The kirigami bandage maintains overall adhesion on the substrate under the same stretch as the continuous bandage.

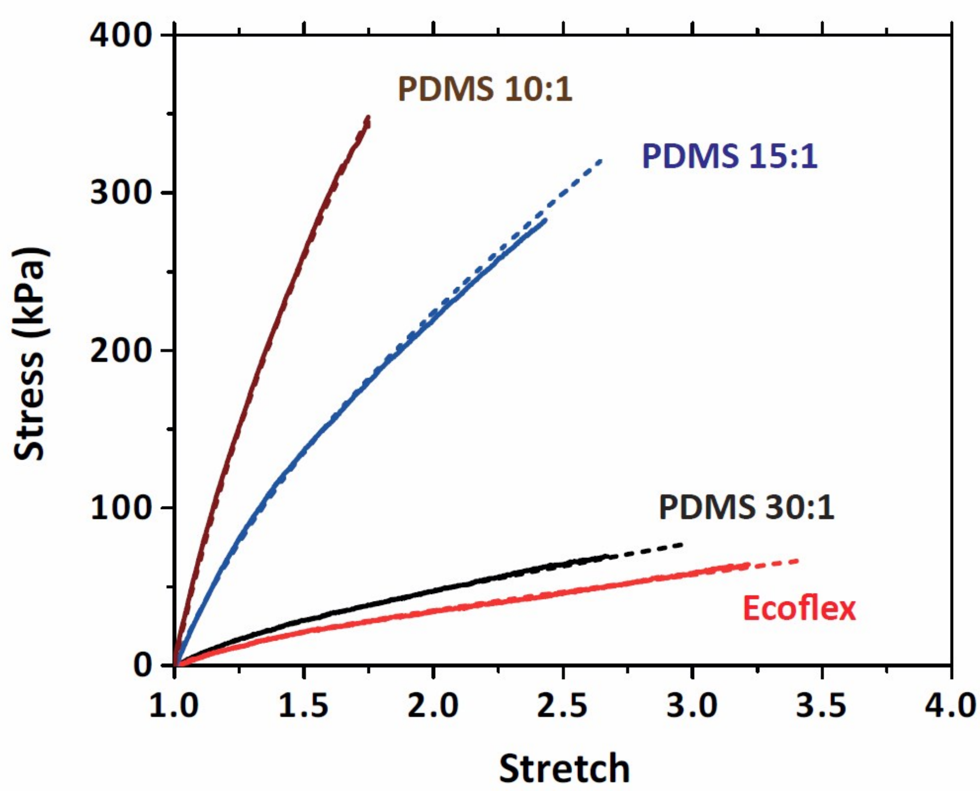

Fig. S5. Material characterization for PDMS with different mixture ratios between base and curing agent (DowCorning Sylgard 184 Silicone Elastomer Kit) and Ecoflex(Smooth-On Ecoflex^{TM} 00-30). For the mixture ratios 10:1, 15:1 and 30:1, the corresponding shear moduli of the PDMS are 245kPa, 128kPa and 27kPa, respectively. The modulus for Ecoflex is 20kPa.

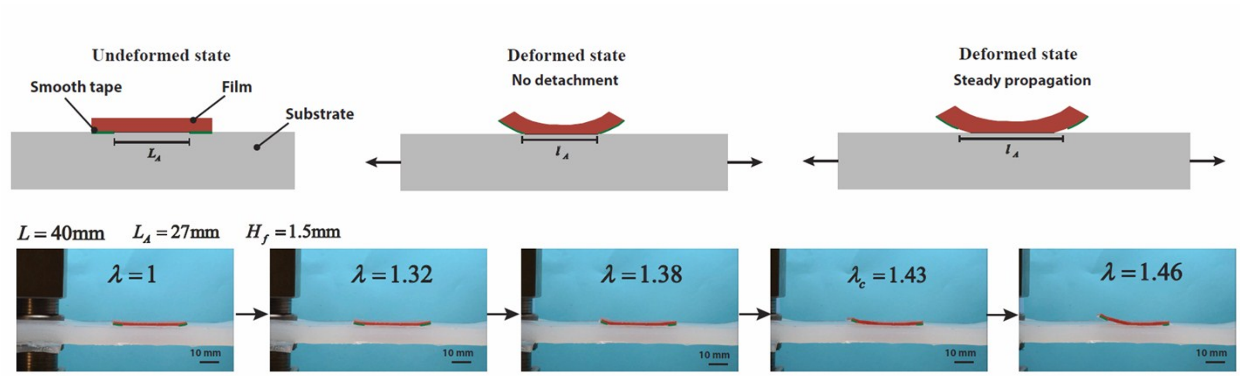

Fig. S6. Identification of the critical stretch for propagation of interfacial crack. The initial cracks at both film edges are induced by applying two thin smooth tapes with negligible adhesion to the film prior to loading. The critical stretch for steady-state crack propagation was identified when the adherent film segment started to detach. In the figure, the critical applied stretch for steady-state crack propagation is identified as $\lambda = 1.43$.

Video Captions

Movie S1:

Comparison of continuous PDMS film and kirigami PDMS film's adhesion under substrate inhomogeneous deformation. While the continuous film detaches from the substrate, the kirigami film remains good overall adhesion to the substrate.

Movie S2:

Comparison of continuous medical bandage (3M™ Elastic Adhesive Bandage) and kirigami medical bandage's adhesion under substrate inhomogeneous deformation. While the continuous bandage detaches from the substrate, the kirigami bandage remains good overall adhesion to the substrate.

Movie S3:

Comparison of continuous PDMS film and kirigami PDMS film's adhesion under elbow's bending motion. While the continuous bandage detaches from the elbow, the kirigami bandage remains good overall adhesion to the elbow under cyclic bending.

Movie S4:

The adhesion performance of the kirigami heat pad on a knee under 100 times 90-degree bending motion of the knee. The kirigami heat pad shows remarkable adhesion to the knee under cyclic bending.

Movie S5:

The adhesion performance of the kirigami heat pad and the corresponding thermal imaging for the heated pad.

Movie S6:

The fabrication process of printing the conductive silver paste to the PDMS kirigami film.

Movie S7:

The experimental video showing the debonding propagation of a kirigami film segment.