Electronic Supplementary Material (ESI) for Soft Matter.

Embedded Interface Regulates Underwater Actuation of Solvent-Responsive Soft Grippers

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Supplementary Information

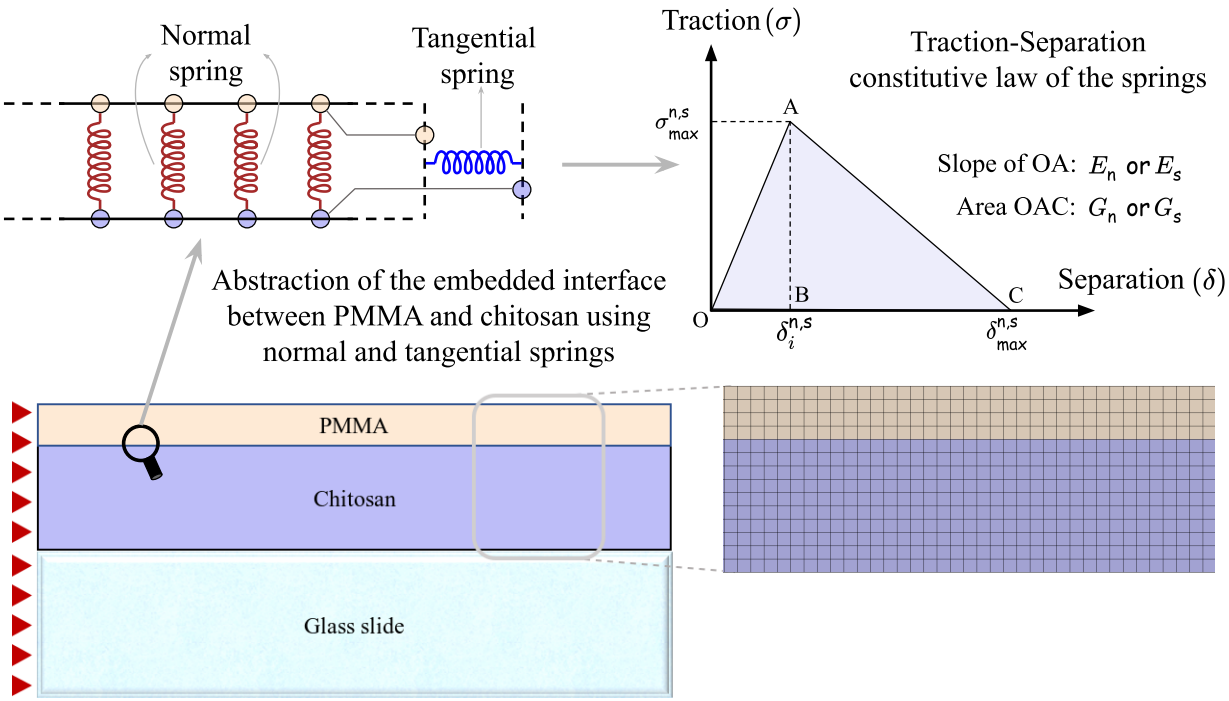

Fig. S1: Schematic of the finite element model along with a representative mesh of the bilayer film. The glass slide is modeled as a rigid body and prevents the film from bending downwards. The diffusion of the solvent molecules is modeled by specifying flux to the bottom portion of the chitosan film. The interface between the PMMA and chitosan films is modeled using a cohesive zone model. The cohesive zone model is idealized through a traction-separation law in normal and shear directions as shown.

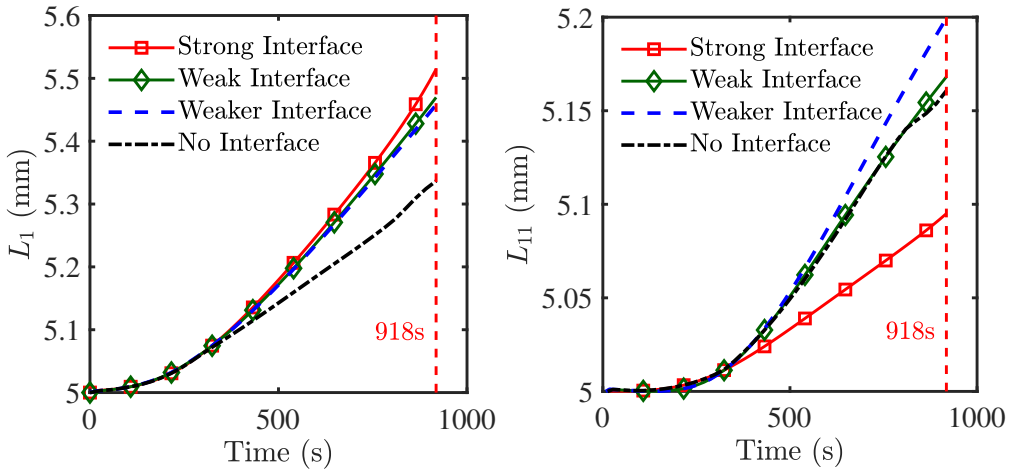

Fig. S2: Evolution of the length of the (a) bottom layer (row 1), and (b) top layer (row 11) of the chitosan film as a function of time. With a decrease in the strength of the silane interface, the diffusion of the solvent reduces, thereby reducing the mean concentration of the bottom row, and consequently, lowering its expansion rate. Hence, L_1 increases with the interface strength. On the other hand, with an increase in the shear stiffness of the silane interface, the resistance encountered by the top row, i.e. row 11 of the chitosan film increases, thereby limiting the expansion. Hence, L_{11} decreases with interface strength.

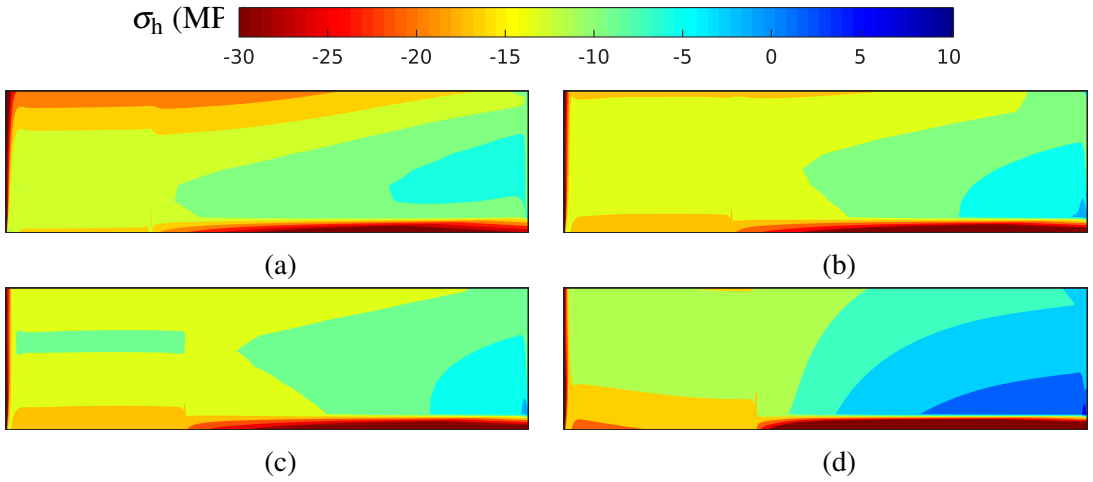

Fig. S3: Contour plots of hydrostatic stress (in MPa) in the chitosan film for (a) Strong interface, (b) Weak interface, (c) Weaker interface, and (d) No interface at 918 s. The compressive stress in the contours is limited to -30 MPa for better illustration. The compressive stresses are the lowest for the Strong interface, resulting in a relatively higher diffusion of the solvent molecules than the other interfaces.

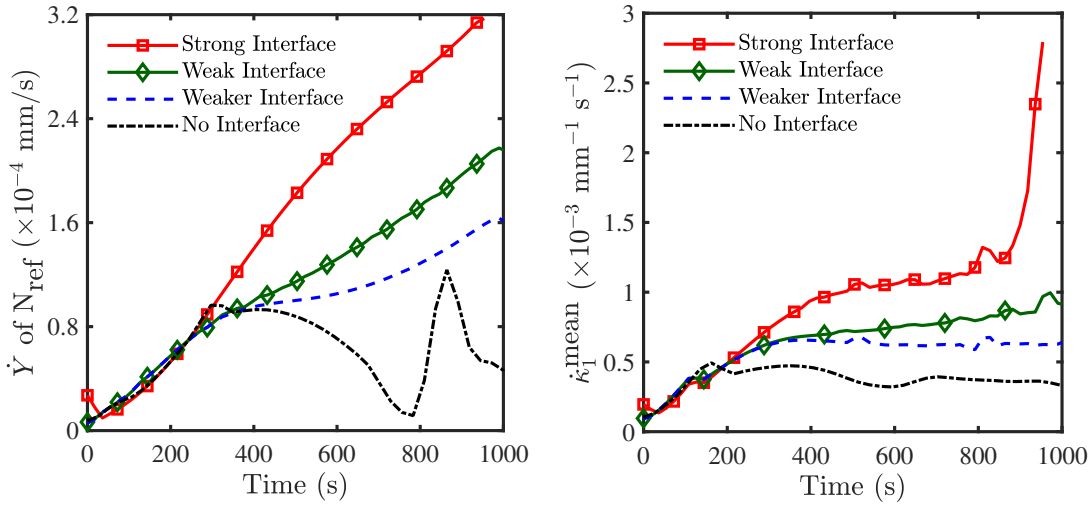

Fig. S4: Rate of change of (a) Y-coordinate of N_{ref}, and (b) mean curvature of row 1, for the four interfaces. The actuation rate, i.e. $\dot{Y}$ is the highest for the Strong interface, and decreases with the interface strength. The actuation rate is proportional to the difference in the rate of expansion of bottom and top layers of the chitosan film. It could also be quantified as the rate of change of mean curvature of the bottom layer, i.e., row 1 of the chitosan film.