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Molecular mechanism for adhesion in humid conditions - lessons from spider glue¹ GAURAV AMARPURI, SARANSHU SINGLA, NISHAD DHOPATKAR, TODD BLACKLEDGE, ALI DHINOJWAL, The University of Akron — Adhesion in humid conditions is a fundamental challenge for both natural and synthetic adhesives. Water lubricates the interface between the adhesive and the substrate resulting in an interfacial failure at high humidity. Yet, glue from most spider species fail cohesively at high humidity, and the spider species from wet habitat show an increase in adhesion with humidity. We use tensile testing, microscopy and surface sensitive spectroscopy techniques to probe the mechanism of spider glue adhesion under high humidity. Humidity responsive structural changes in the glue structure are observed both at the interface and in bulk. However, the humidity responsiveness is lost after washing the water soluble low molecular weight molecules (LMM) from the glue. Many natural systems display a functional response to their environment, but spider glue's humidity responsiveness is a novel adaptation that makes the glue stickiest in each species' preferred habitat. This tuning is achieved by a combination of proteins and hygroscopic LMM that respond to humidity in a unique way. We therefore anticipate that manipulation of polymer-LMM interaction can provide a simple mechanism to design humidity responsive smart adhesives.

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Gaurav Amarpuri
Univ of Akron

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