ID contributo: **10** Tipo: **Presentazione orale**

Enhancing the adhesive strength of soft viscoelastic contacts with microvibrations: an experimental and numerical study

venerdì 5 settembre 2025 12:15 (15 minuti)

Surface adhesion is a key material property in several engineering applications. In the past decades, many efforts have been made in mimicking nature to achieve outstanding adhesion performances. A well-known example is given by geckos, which are able to climb walls at a pace of up to 0.8 m/s thanks to the hierarchical structure of their feet, that allows them to quickly (in the order of tens of milliseconds) adjust surface adhesion. Drawing inspiration by geckos, a controlled tuning of interface adhesion could potentially be crucial to a broad range of applications, such as soft robotics, space technology, micro-fabrication, and flexible electronics.

Recently, high-frequency micrometrical vibrations have been proposed as a promising approach for fast adhesion tuning, due to their capability to significantly enhance or diminish the adhesive performance of soft interfaces [1]. However a detailed comparison between theoretical predictions and experimental results is still missing.

In this talk, the problem of "vibroadhesion", i.e. the adhesive behaviour of vibrating viscoelastic contacts, will be addressed.

The experimental tests were performed by unloading a spherical indenter from a soft PDMS substrate excited by high-frequency micrometrical vibrations. We show that as soon as the vibration starts, the contact area increases abruptly and then progressively decreases upon unloading, following approximately the JKR classical model, but with a much increased work of adhesion. We observe an enhancement of the pull-off force when the amplitude of vibration is increased, up to a certain saturation level. Under the hypothesis of short range adhesion, a lumped mechanical model was derived, which, starting from an independent characterization of the rate-dependent interfacial adhesion, predicted qualitatively and quantitatively the experimental results [2].

Moreover, the effect of parameters like material properties, sample thickness, sphere radius, preload and unloading rate was explored.

References:

[1] Shui, L., Jia, L., Li, H., Guo, J., Guo, Z., Liu, Y., … & Chen, X. (2020). Rapid and continuous regulating adhesion strength by mechanical micro-vibration. Nature communications, 11(1), 1583.

[2] Tricarico, M., Ciavarella, M., & Papangelo, A. (2025). Enhancement of adhesion strength through microvibrations: modeling and experiments.
Journal of the Mechanics and Physics of Solids, 158, 106020.

Autore principale: TRICARICO, Michele (Politecnico di Bari)

Coautore: Prof. PAPANGELO, Antonio (Politecnico di Bari); Prof. CIAVARELLA, Michele (Politecnico di Bari)

Relatore: TRICARICO, Michele (Politecnico di Bari)

Classifica Sessioni: Meccanica dei Materiali

Classificazione della track: Meccanica dei Materiali