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ADHESION ON ROUGH SURFACES: THE ROLE OF VISCOELASTICITY

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5 selected publications on adhesion

- D. Derks, A. Lindner C. Creton et D. Bonn, *Cohesive failure of thin layers of soft model adhesives under tension,* J. Appl. Phys. 93 (2003) 1557
- J. Nase, A. Lindner and C. Creton, *Pattern formation during deformation of a confined viscoelastic layer: From a viscous liquid to a soft elastic solid,* Phys. Rev. Lett. 101, (2008), 074503

Continued on next page

- J. Nase, O. Ramos, C. Creton, L. Sonneberg, T. Yamaguchi and A. Lindner, *A Measurement of the contact angle at the interface between a viscoelastic material and a rigid surface,*Soft Matter, 6 (2010) 2685-2691
- D. Martina, C. Creton, P. Damman, M. Jeusette and A. Lindner, *Adhesion of soft viscoelastic adhesives on periodic rough surfaces,* Soft Matter**,** 2012, 8 (19), 5350 - 5357
- C. Davis, D. Martina, C. Creton, A. Lindner and A. Crosby, *Enhanced Adhesion of Elastic Materials to Small-Scale Wrinkles,* Langmuir (2012) DOI: 10.1021/la302314z

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Efficiently bonding a viscoelastic material to a rough surface is an important problem in everyday life and many industrial applications. The debonding of elastic materials from rough surfaces has been intensely studied and the main mechanisms are now well understood. The role of viscoelasticity is, however, less well understood. Here we address this question by studying the adhesion of viscoelastic model materials on surfaces with controlled periodic roughness.

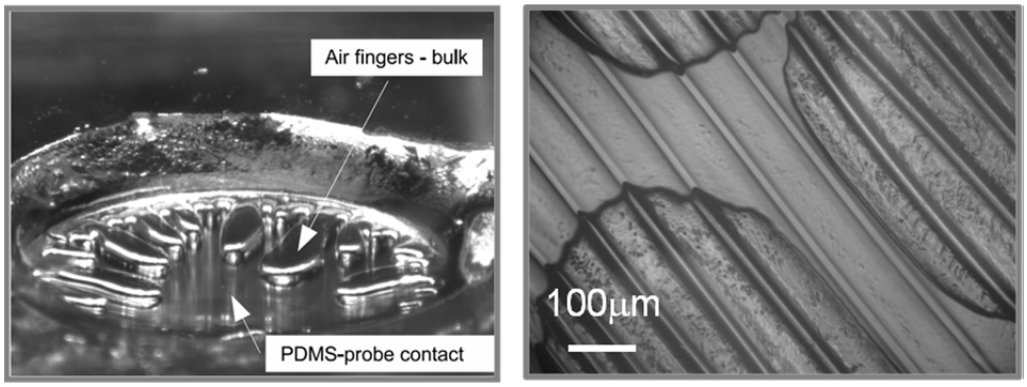

Figure: Left) Air fingers penetrating into a viscoelastic material during debonding. Right) Debonding of a viscoelastic material from a periodic rough surface.

In a first step, we characterize the respective influence of elastic and viscous properties on the debonding mechanisms using homogeneous adhesive layers of a model system, allowing to go from a purely liquid, to a viscoelastic material and finally to a soft elastic solid within one material family [1]. A new 3D visualization technique allows us to characterize the exact boundary condition between the adhesive and the solid substrate during debonding [2].

We then study these materials on surfaces with well-defined periodic roughness. Depending on the material properties and the surface roughness an increase or a decrease of the adhesion energy can be observed [3,4]. The detailed results show that the macroscopic adhesion energy depends on a fine balance between the elastic energy released by the adhesive upon decompression and the viscous dissipation near the contact line during adhesive detachment.

[1] J. Nase, A. Lindner and C. Creton, *Pattern formation during deformation of a confined viscoelastic layer: From a viscous liquid to a soft elastic solid,* PRL, 101, (2008), 074503
[2] J. Nase, O. Ramos, C. Creton, L. Sonneberg, T. Yamaguchi and A. Lindner, *A Measurement of the contact angle at the interface between a viscoelastic material and a rigid surface,* Soft Matter, 6 (2010) 2685-2691
[3] D. Martina, C. Creton, P. Damman, M. Jeusette and A. Lindner, *Adhesion of soft viscoelastic adhesives on periodic rough surfaces,* Soft Matter**,** 2012, 8 (19), 5350 - 5357
[4] C. Davis, D. Martina, C. Creton, A. Lindner and A. Crosby, *Enhanced Adhesion of Elastic Materials to Small-Scale Wrinkles,* Langmuir (2012) 28 (42), pp 14899–14908