Magneto-active substrates for local mechanical stimulation of living cells

C. M. Bidan[a], M. Fratzl[b,c], A. Coullomb[a], P. Moreau[a], A. H. Lombard[a*], I. Wang[a], T. Boudou[d], N. M. Dempsey[b], M. Balland[a], T. Devillers[b] and A. Dupont[a]

a. Univ. Grenoble Alpes, CNRS, LIPhy, 38000 Grenoble, France
b. Univ. Grenoble Alpes, CNRS, Grenoble INP, Institut Néel, 38000 Grenoble, France
c. Univ. Grenoble Alpes, CNRS, Grenoble INP, G2Elab, 38000 Grenoble, France
d. Univ. Grenoble Alpes, CNRS, Grenoble INP, LMGP, 38000 Grenoble, France

∗ alain.lombard@univ-grenoble-alpes.fr

The cellular response to an external mechanical stimulation has been investigated with various static and dynamic systems, so far limited to global deformations or to local stimulation through discrete substrates. To apply local and dynamic mechanical constraints at the single cell scale through a continuous surface, we have developed and modelled magnetoactive substrates made of magnetic micro-pillars embedded in an elastomer. Constrained and unconstrained substrates are analysed to map surface stress resulting from the magnetic actuation of the micro-pillars and the adherent cells. These substrates have a rigidity in the range of cell matrices, and the magnetic micro-pillars generate local forces in the range of cellular forces, both in traction and compression. As an application, we followed the protrusive activity of cells subjected to dynamic stimulations. Our magneto-active substrates thus represent a new tool to study mechanotransduction in single cells, and complement existing techniques by exerting a local and dynamic stimulation, traction and compression, through a continuous soft substrate. The coupling of the magneto-active substrates with FRET-based biosensors reporting in live the biochemical activity of Rho-GTPases will allow studying mechanotransduction with spatio-temporal correlations between mechanical and biomechanical signals.

[1] *Magneto-active substrates for local mechanical stimulation of living cells*, C. M. Bidan[1], M. Fratzl[2,3], A. Coullomb[1], P. Moreau[1], A. H. Lombard[1*], I. Wang[1], T. Boudou[4], N. M. Dempsey[2], M. Balland[1], T. Devillers[2] and A. Dupont[1], Scientific Reports (**2018** 8 :1464)

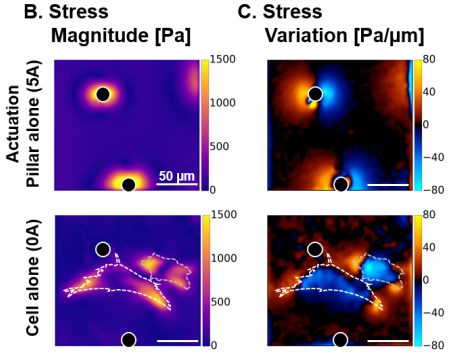

Figure 1: Stress maps in TFM with and without cells