

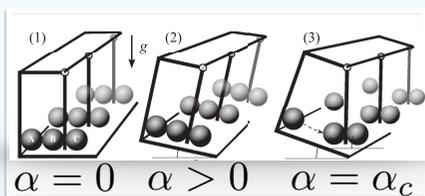
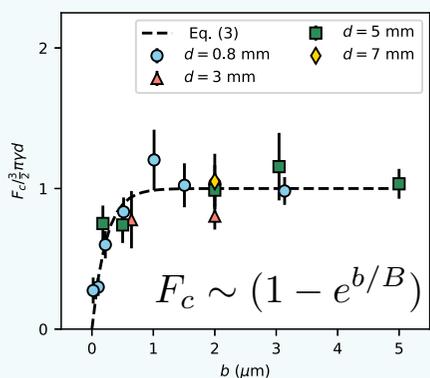
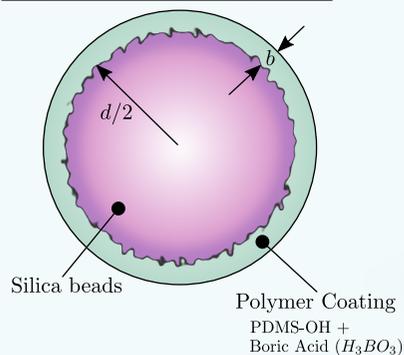
# Rheology of Cohesion-Controlled Granular Materials

F.M. Rocha<sup>1</sup>, F. Tapia<sup>1</sup>, A. Gans<sup>2</sup>, M. Nicolas<sup>1</sup> & O. Pouliquen<sup>1</sup>

<sup>1</sup>Aix-Marseille University, CNRS, IUSTI, Marseille 13453, France

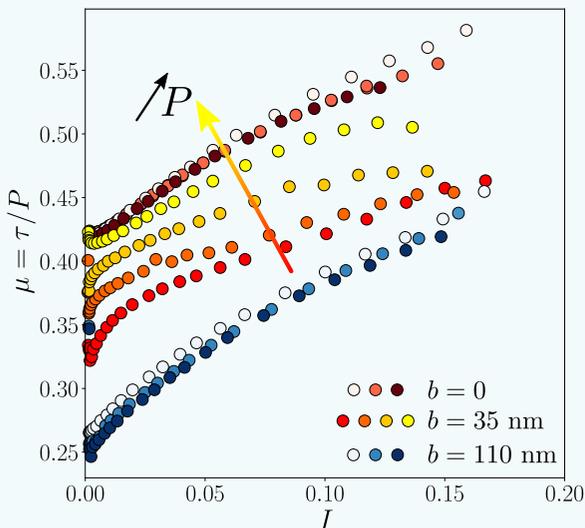
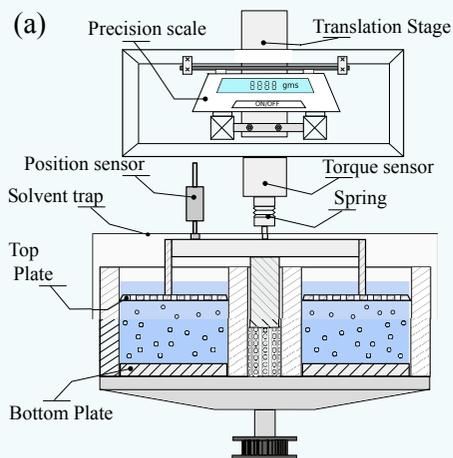
<sup>2</sup>CNRS, LEMTA, Université de Lorraine, F-54000 Nancy, France

## A Model Cohesive Material



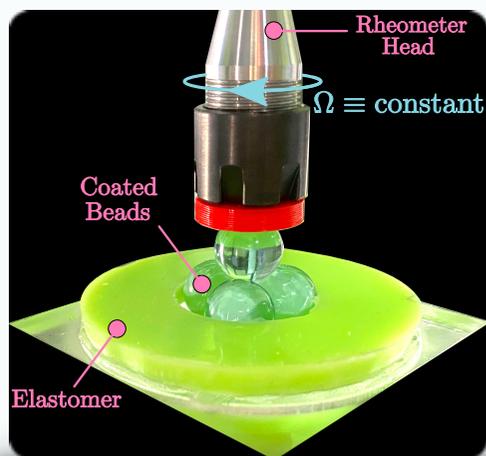
Gans *et al.* PRE (2020)

## Bulk Rheology

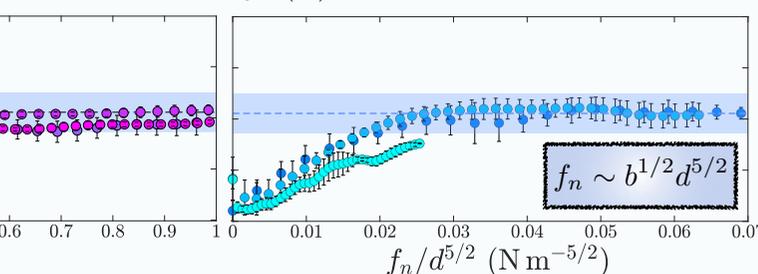
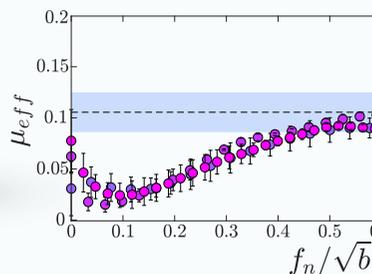
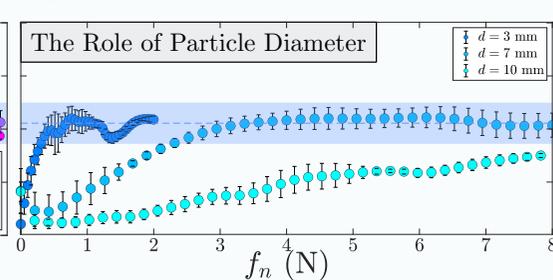
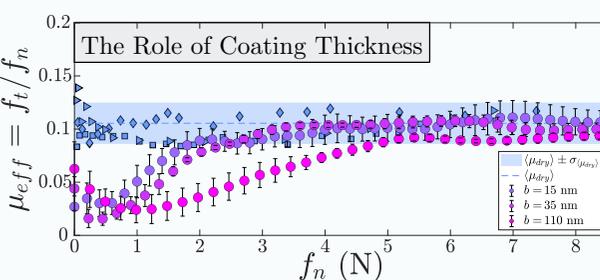
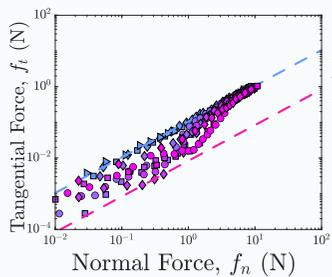


**FRictionless to FRictional transition as the confining pressure is increased!**

## From Micro to Macro: A frictional transition at the grain scale



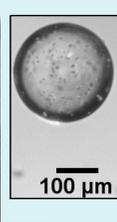
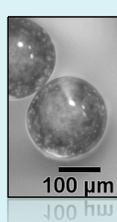
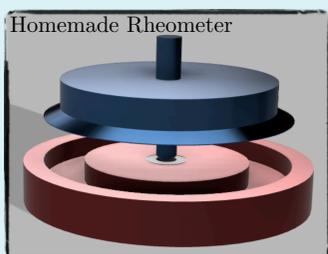
A Four Ball Tribology Setup



Reversible lubrication transition at the grain scale leads to the **FRictionless to FRictional transition** in the bulk rheology.

## Perspectives

### Rheology of Powders



Rheology at low/high stress

Tensorial formulation

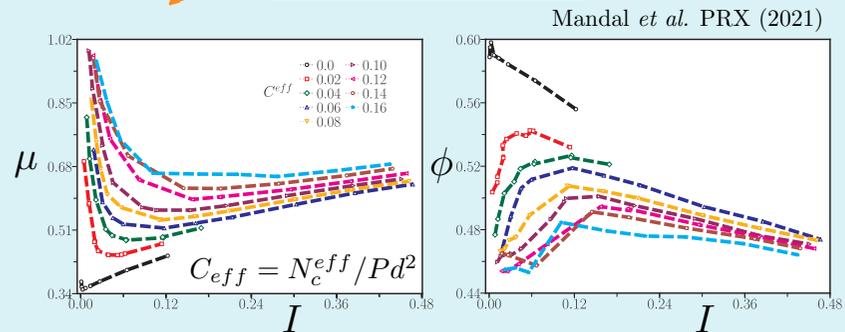
Flow of Powders

adhesion & stiffness

Can be **tuned** with  $\mu$ Particles  
Tailored with Click-chemistry

E. Drockenmuller, N. Sintès, K. Haumeer IMP Lyon

### DEM Simulations



Constitutive Relations

$$\tau = \mu(I, C_{eff})P$$

$$\phi = \phi(I, C_{eff})$$

$$N_c^{eff} = N_c \left[ \left( \frac{N_c}{k_n d} \right)^a \left( \frac{1}{Q^b} \right) \right]$$

Adhesion Stiffness Dissipation

