Characterization of sphere-sphere attraction / repulsion forces with structured substrates

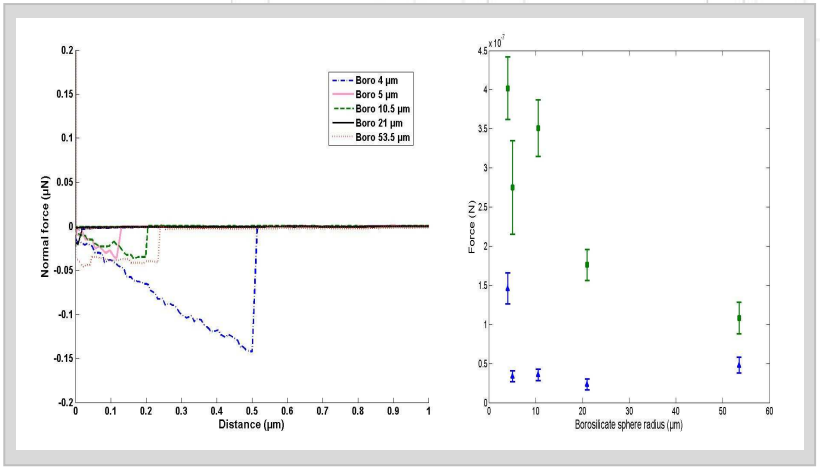
Research framework

The adhesion that occurs between a micro-object and a micro-manipulation tool like the end-effectors of a micro-gripper is an important issue in micro-manipulation and micro-assembly. Adhesion forces cancellation or reduction in a predictable way is also a great challenge in microrobotics.

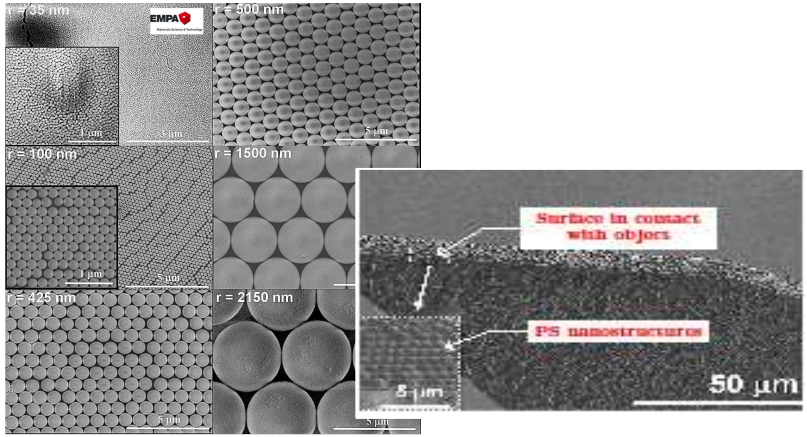
Because the adhesion force is linked to the surface structure of both the object and the gripper, the modeling and the experimental validation of this force for structured surfaces is necessary to plan and achieve reliable microrobotics tasks.

Proposed approach

Force interactions between a micrometric sphere and a structured plane substrate were experimentally studied and modeled. The structured substrate is made of layers of polystyrene PS spheres created by spin coating. The characterization of the pull-off force was performed with a rectangular silicon AFM cantilever with a microsphere glued in place of the standard AFM tip. This microsphere is supposed to interact with 3 spheres at the most on the structured substrate because of the chosen spheres radius on the substrate. All experimental measurements were performed with the NANOROL robotics platform specifically dedicated to micro-force measurements. A multisphere van der Waals force model was proposed. This model and the experimental measurements show the existence of an optimal value of the microspheres radius which minimizes the adhesion. The aim is to extend this model and to demonstrate the relationship between this minimum value and the microsphere's diameter and nature.



Pull-off force measurement between a structured surface (PS spheres with a 100 nm radius r_2) and different borosilicate spheres whose radius r_1 is from 5 to 50 µm.



Examples of structured substrates with PS particles (spheres).

Major article: Adhesion control for Micro- and Nano-Manipulation. Dejeu J., Bechelany M., Rougeot P., Philippe L., Gauthier M. ACS Nano, 2011, 5(6):4648-4657

Contact: patrick.rougeot@femto-st.fr

SPECIMeN Group

Sensing strategies, Perception and Characterization at Micro- and Nano-scales

AS2M Dep^{t} – Automatic Control and Micro-Mechatronic Systems

http://www.femto-st.fr/fr/Departements-de-recherche/AS2M/Accueil/