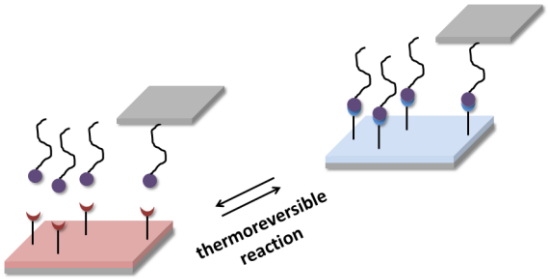
# Reversible Strong Adhesion via smart plasma polymer coatings

DIRECTEUR DE THESE : VINCENT ROUCOULES
CO-ENCADRANTE : FLORENCE BALLY-LE GALL
INSTITUT DE SCIENCE DES MATERIAUX DE MULHOUSE (IS2M), 15, RUE JEAN STARCKY, 68057 MULHOUSE
TEL : 03 89 60 88 04
E-MAIL : FLORENCE.BALLY-LE-GALL@UHA.FR OU VINCENT.ROUCOULES@UHA.FR

Adhesive bonding is used in all fields of industry to assemble materials. Automotive, electronics, construction and biomedical fields continuously strive to develop new adhesive formulations and tailor the associated mechanisms of adhesion. In the context of **sustainability and recycling**, an efficient adhesive would i) create strong adhesion between two materials and ii) lose its adhesive properties under a specific stimulus. In order to develop such a smart adhesive and more interestingly to achieve **reversible strong adhesion**, **polymer thin films containing Diels-Alder thermoresponsive groups** (diene / dienophile) **and having appropriate viscoelastic properties will be investigated**. These functional coatings will aim at **controling chemical and physical interactions at interfaces according to the temperature**.

Recently, the Institute of Materials Science of Mulhouse (IS2M) has started to work on smart interfaces with thermoreversible properties. Outstanding preliminary results have been obtained, enabling: i) a quantitative characterization of Diels-Alder reactivity on functional polymer coatings (containing diene / dienophile groups), and ii) a proof of concept of reversible adhesion, controlled by a simple temperature change, between a model biomolecule and a plasma polymer thin film and between two macroscopic materials, each coated with a complementary Diels-Alder reactive plasma polymer.[1] However, the value of the adhesion strength measured especially between two macroscopic materials remains limited. Furthermore, the reversibility of the adhesion process seems to be limited to a certain number of assembly/disassembly cycles. Therefore, there is urgent to advance our understanding on interfacial Diels-Alder and retro-Diels-Alder reactions. In particular, the following open questions should be adressed: **What is the contribution of viscoelastic properties of the functional coating in the adhesion phenomenon? What are the main driving forces involved in the disassembly process?**

**3 scientific challenges** will be addressed during this PhD work: i) the fabrication of thermoresponsive plasma polymer coatings with various viscoelastic properties, ii) the thorough investigation of their interfacial reactivity leading to reversible adhesion. iii) the proof of concept of reversible strong adhesion between various objects.




*Schematic illustration of the concept of reversible strong adhesion.*

By tailoring the engineering and the reactivity of these responsive nanocoatings, it is expected to control, at the nanometric scale, adhesion phenomena at the interface between a surface and (bio)molecule, between functional (nano)particles or between macroscopic materials.

[1] M. Vauthier, L. Jierry, F. Boulmedais, J.C. Oliveira, K.F.A. Clancy, C. Simet, V. Roucoules, F. Bally-Le Gall, Langmuir 34, 11960 (2018); M. Vauthier, L. Jierry, M. L. M. Mendez, Y. M. Durst, J. Kelber, V. Roucoules, F. Bally-Le Gall, Journal of Physical Chemistry C 123(7), 4125-4132 (2019); M. Vauthier, L. Jierry, J. C. Oliveira, L. Hassouna, V. Roucoules, F. Bally-Le Gall, Advanced Functional Materials 29, 1806765 (2019).