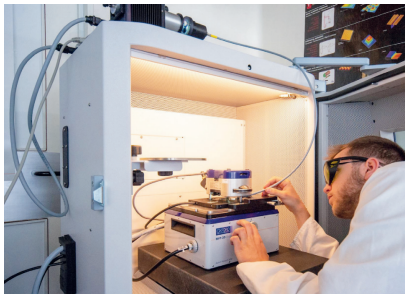
Founded in 2006, the NanoChem group has 8 PhD students (more to come by the end of 2024), 4 post-docs and 1 senior researcher. Its fundamental research work is supported by 7 customized atomic force microscopy facilities and one optical tweezer. A rarity for this research group, which has a total of 7 ongoing projects.

A multidisciplinary team and unique techniques



© NanoChem group

Physical chemists, organic chemists, physicists, biophysicists and engineers: the NanoChem group team is resolutely multidisciplinary. Its annual budget is funded entirely by programmes of fundamental research run by the FNRS, the European Commission, EOS and ARC. It is one of the few laboratories in the world to use and develop a specific technique: force spectroscopy on a single molecule. The aim? To trap and stretch a molecule using an atomic force microscopy device or optical tweezers in order to probe mechanical forces in real time in a defined medium (a liquid where the environment is controlled, for example). It is even possible to induce chemical reactions and molecular processes, such as changes in the conformation or nature of the bonds involved, movements or the production of forces. NanoChem was the first to succeed in probing small synthetic molecules, as small as 1 nanometer long.

Four key areas of research

Drawing on this unique expertise, NanoChem is developing four areas of research: molecular recognition (between chemical species or between partners with a view to measuring interaction forces), the mechanics of molecules (following the example of helices in proteins or folds whose properties are being studied), mechanochemistry (study of how mechanical forces and chemistry affect each other) and molecular machines: for the past 15 years, the NanoChem group has been conducting research projects in this last area, with funding from the FNRS and the European Commission (FET-Open and Marie Curie-Skłodowska doctoral networks). The aim is to understand the basic operating mechanisms of synthetic molecular machines (analogous to natural machines such as those governing muscle contractions, ATP synthesis, etc.) and measuring the forces they generate.

Prestigious awards and groundbreaking discoveries

The originality of NanoChem's research has earned it the prestigious International Feynman Prize in Nanotechnology in 2021 and an ERC Advanced Grant for a major 5-year research project in mechanochemistry. The aim of this project is to study the mechanics of basic chemical bonds that have hitherto been known only from a thermodynamic point of view. In the case of molecular stretching, bonds that are strong from a thermodynamic point of view are not necessarily strong from a mechanical point of view, and vice versa. We are therefore witnessing a veritable paradigm shift thanks to mechanochemistry, which is making it possible to study with fresh eyes the influence of the environment and the geometry of molecular bonds on their strength, resistance and even their ability to reform. In the long term, this work should make it possible to design much stronger and more resistant materials. Another possible area of application is biotechnology and medicine. Our cells are subjected to a great deal of stress in the form of multiple forces, deformations and strains. We therefore need to take greater account of the mechanics of the bonds that underlie their constituent molecules.

Global collaborations and new scientific frontiers

The NanoChem group has developed numerous international academic collaborations. The universities of Manchester (United Kingdom), Northwestern (United States), Groningen (Netherlands), Toulouse, Paris, Bordeaux and Strasbourg (France), Bologna (Italy), Madrid (Spain), Munich, Dresden and Aachen (Germany), Graz (Austria) and Fudan in Shanghai (China) regularly call on its expertise. Thanks to single-molecule mechanochemistry, the NanoChem group has access to information that is inaccessible using classical ensemble techniques and can therefore ask and answer new questions about reactions and processes in chemistry. New concepts are emerging to address this disturbing reality: the laws of thermodynamics are no longer valid on a molecular scale. A very promising new field of research!

NanoChemistry &

Molecular Systems
University of Liège – Quartier Agora
Allée du Six Août 13, B6a (+4)
B-4000 Sart Tilman
Tel.: +32 (0)4 366 34 82
Email : asduwez@uliege.be
https://www.nanochem.uliege.be/cms/c_9148355/en/nanochem