Summaries of the winning projects of the "Collaboration Grants" 2019

POTOC – Testis-on-chip approach to elucidate the impact of environmental plastic pollution on male fertility

Project leaders: Prof. Stefan Schlatt from the Centre for Reproductive Medicine and Andrology (CeRA) at the University of Münster, Prof. Séverine Le Gac from the Applied Microfluidics for BioEngineering Research group at the Faculty of Electrical Engineering, Mathematics and Computer Science at the University of Twente

The proposed collaborative research between two teams located at the WWU (CeRA, Prof. Stefan Schlatt) and at the University of Twente (UT, AMBER, Prof. Séverine Le Gac), will respectively focus on the biological (WWU) and technological (UT) aspects of environmental plastic pollution on male fertility (Plastics-on-Testis-on-chip, POTOC). A decline in male reproductive health and fertility over the last 50 years has evoked extensive research efforts to identify potential risk factors causing male infertility. Beside genetic abnormalities or infertility-related disease etiologies, a change in lifestyle and exposure to environmental cues are considered to significantly contribute to declining male infertility and poor sperm parameters. This project aims to develop a valid test system to evaluate potential adverse effects of environmental chemicals (e.g. plasticizers, phthalates, bisphenols, pesticides and fungicides) and pharmaceuticals on adult human testis function. Development of a robust and physiologically relevant *in vitro* screening platform using human tissue will be essential to evaluate the effect of varying degrees of environmental exposure of plastic particles or components on testis function.

In this project, organ-on-chip technology will be employed to build microfluidic platforms to evaluate reproductive toxicology on *ex vivo* human testis tissue. We aim in establishing a proof-of-concept for toxicity screening using known toxicants in the form of micro/-nanoplastics without the use of animals. The two research teams at the WWU and at the University of Twente have been collaborating for over a decade on frontiers research allying reproductive biology/medicine with microfluidics. Both partners have expertise in complementary fields, namely microfluidics and andrology. This creates the foundation of the proposed research. The strength of this unique bilateral collaboration is based on outstanding technological and scientific knowledge and exclusive expertise on both sides. The partnership is crucial as it generates a unique setting with symbiotic actions from both sites.

Further Information:

Centre for Reproductive Medicine and Andrology (CeRA) at the University of Münster
Applied Microfluidics for BioEngineering Research group at the University of Twente

ENERGIES – Thermal Conduits for Energy Conversion and Management in Batteries

Project leaders: Prof. Nikos Doltsinis from the Institute for Solid State Theory at the University of Münster, Dr. Jimmy Faria from the Faculty of Science and Technology, Prof. Bojana Rosic from the Applied Mechanics and Data Analysis group, and Dr. Miguel Muñoz Rojo from the Department of Thermal and Fluid Engineering at the University of Twente

Batteries play an increasingly important role in our lives – from the storage of renewable energy to electromobility. Fluctuations in temperature in batteries are a big problem, however, as these fluctuations have a considerable negative impact on the efficiency and lifespan of batteries. The idea of this project, therefore, is to develop a special coating for batteries which makes it possible for the battery to operate at a constant temperature. Firstly, the aim is to dissipate excess heat in an efficient way and convert it back into electricity. And secondly, in this way, heat can be supplied at cold temperatures by means of thermoelectric generators.

The project brings together researchers from a variety of scientific disciplines. First of all, Jimmy Faria produces multi-layered heat-conducting materials, and their heat-conducting properties are then studied by Nikos Doltsinis by means of computer simulations at the atomic level. At the same time, Miguel Muñoz Rojo measures the thermal conductivity of these materials. The findings which result from the simulations and experiments are then, in turn, fed into the design of improved materials. The most promising heat-conducting materials are subsequently integrated into virtual battery systems with dynamic heat management and tested using computer simulations by Bojana Rosic. This combination of the different expertise which each of the four project leaders contributes enables them to adopt an integrated, multi-layered approach that takes into account on an equal footing microscopic quantum mechanical aspects and the technical realization of the concept. The interdisciplinary orientation of the project has great potential for the future development of batteries with dynamic heat management.

Further Information:

Institute for Solid State Theory at the University of Münster
Faria Group at the University of Twente
Applied Mechanics and Data Analysis group at the University of Twente
Advanced Materials for Energy Applications and Thermal Management group at the University of Twente

Smart Soft Coatings – Towards new strategies for sensing and separation

Project leaders: Prof. Uwe Thiele from the Institute of Theoretical Physics at the University of Münster, Prof. Sissi de Beer from the Materials Science and Technology of Polymers group, and Prof. Jacco Snoeijer from the Physics of Fluids group at the University of Twente

This project deals with the theoretical foundation for developing so-called "smart" surfaces whose central element are polymer brushes. These are soft, flexible, nanoscopic hairs with one end having a stable attachment to solid surfaces. These brushes react to changes in ambient conditions, and this can for example be used for detecting gases – the development of "artificial noses", among other things – or for separating valuable resources from waste streams.

To this end, the researchers are developing multi-scale models to describe the behaviour of smart surfaces in dynamic situations. The groups from Münster and Twente involved in the project have different expertise, which complement each other in the modelling of polymer brushes across different scales. Sissi de Beer and Jacco Snoeijer will carry out molecular-dynamic simulations of the behaviour of the brushes at microscopic scales. From this, the researchers together extract parameters and dependencies which are fed into the models developed by Uwe Thiele for the combined brush- and fluid-dynamics at so-called mesoscopic scales. This approach allows the researchers to further develop the models on different scales in parallel. The specific task which the project members have is to apply the different modelling approaches to the adsorption dynamics of a tiny drop into the polymer brush and then combine these approaches with one another. The bilateral project shall form the basis for an international project which brings in further research groups.

Further Information:

Institute of Theoretical Physics at the University of Münster
Materials Science and Technology of Polymers group at the University of Twente
Physics of Fluids group at the University of Twente