

Université de technologie de Compiègne – Thesis proposal

Part 1: Scientific sheet	
Thesis proposal title	Investigation of nanoparticle size effect on the properties of nano-reinforced polymers
PhD grant	SU-IMAT
Research laboratory	unité de recherche : Roberval Laboratory
Thesis supervisor(s)	Fahmi BEDOUI
Scientific domain(s)	Materials science Science and technology Physics
Research work	<p>This thesis project is dedicated to the study of the size effects of nanoparticles and their surface chemistry on the macroscopic properties (thermal, mechanical, etc.) of nano-reinforced polymeric materials. These new materials will be developed through the controlled dispersion of nanoparticles of variable diameter ranging from 3 to 20 nm and of variable surface chemistry, which will depend on the polymer matrix used. Recent experimental work carried out previously shows an improvement in the mechanical properties of this class of materials when the size of the particles decreases. However, only sizes greater than 15 nm could be studied. In addition, more recent modeling work (theoretical, atomistic simulations) show that this effect is significantly accentuated when the size becomes less than 10 nm. To date, this effect has not been explored experimentally for such small sizes. In addition, at nanoscopic scales where the main deformation mechanisms are at play, the nature of the interfaces plays an important role. To understand the mechanisms responsible for the observed improvements, the elaboration of model materials with nanoparticles characterized by well-controlled size and surface chemistry as well as an adequate choice of polymer matrix are of great importance. Beyond the effect on the mechanical properties, the materials obtained will allow a more general observation of the size effect: thermal, electrical etc. The project challenge lies on how to link the key parameters at the nano-scale to the observed measurable properties (mechanical, thermal, electric etc.) on rigorously prepared model materials. Neither mechanical engineering nor physical chemistry researchers alone could address these issues. Therefore, a myriad of complementary expertise's will join the project: colloidal synthesis of nanoparticles with appropriate sizes and surface chemistry (Isabelle Lisiecki MONARIS-SU), polymer processing and multi-scale characterization of nano-reinforced polymers (Fahmi Bedoui ROBERVAL-UTC) and micromechanical modeling of nano-reinforced materials (Djimédo Kondo IJLRDA-SU). The micromechanical modeling tools will, <u>when necessary</u>, guide the interpretation of the results obtained and ultimately the determination of the optimal parameters for the development of these new materials.</p> <p>This PhD. thesis will be intended for master's students who have strong foundation in polymer physical chemistry and are willing to venture outside narrow specialization and excel in interdisciplinary areas</p>
Key words	Nano-reinforced polymers, size effects, multi-scale modeling and characterization
Requirements	Master in materials science
Starting time	October 2021
Location	UTC – Compiègne, sorbonne University Paris

Part 2: Job description	
Duration	36 months
Additional missions available	
Research laboratory	Roberval Laboratory- UTC, MONARIS Sorbonne University, IJLRDA Sorbonne University
Material resources	Nano-particle synthesis platform, Characterization platform, Modeling softwares
Human resources	
Financial resources	+ 10K
Working conditions	Curious, open minded and autonomous student
Research project	
National collaborations	Sorbonne University
International collaborations	California Institute of Technology
International cosupervision (cotutelle)	
Contact	fahmi.bedoui@utc.fr

Please contact first the thesis supervisor before applying online on <https://webapplis.utc.fr/admissions/doctorants/accueil.jsf>