Title of the thesis	**Na**no-therapeutics for **t**opical treatment of **o**cular diseases
Acronym	NATO
Reference number	004

Hosting institution	**Employer**
Université de Lille Website: https://www.univ-lille.fr/home/	CNRS Website: http://www.cnrs.fr/en
Hosting research unit 1	**Hosting research unit 2**
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Thesis information

Keywords	carbon quantum dots (CQDs); ocular disease, topical application; cataract, corneal wound healing
Abstract	Today treatment of many ocular diseases remains rather invasive as surgery or injections of drugs in the eye are needed. This project aims to investigate the **potential of nanotechnology for a non-invasive treatment** of respectively **cataract**, the clouding of the clear lens, and vitreous opacities (also named 'floaters'). Diabetes and aging are the main causes of cataract and vitreous opacities, which arise through progressive aggregation of proteins (collagen) in the lens (cataract) and the vitreous (floaters). The proposed PhD thesis will focus on **carbon-based quantum dots** (CQDs), being light sensitive nanoparticles, which produce heat and/or water vapour nano-bubbles upon irradiation with pulsed laser light. **One aim** of the project is to design CQDs which, following topical application at the surface of the eye, can spontaneously pass the cornea and reach the lens capsule and the vitreous. The fact that CQDs are ultra-small (<10 nm) makes them attractive, as the size of the nanoparticles will play a major role in their transport over the cornea. In preliminary experiments, the Lille and Ghent teams observed very recently that CQDs exhibit a capacity to open tight junctions between corneal epithelial cells,

	being an attractive observation. As a **second objective**, the project aims to evaluate whether irradiation of CQDs with a pulsed laser light is able to form pores in the capsule which surrounds the lens. Such pores could allow the transport of drugs into the lens to treat the protein aggregates (cataract); note that technologies which allow efficient delivery of drugs over the lens capsule into the inner part of the lens are currently not existing. Considering the fact that current therapies for vitreous floaters are invasive and lack efficacy, the **third objective** is to evaluate whether topically applied CQDs can (i) sufficiently accumulate in the vitreous, (ii) bind to collagen floaters, and (iii) physically destroy the floaters upon irradiation with a pulsed laser. This co-tutorial PhD project at the interface between nanotechnology, medicine and pharmacy is built on the expertise of the **NanoBioInterfaces team of IEMN (Univ. Lille)** and the **Ghent Research Group on Nanomedicines (Ghent University).** Secondments of up to three months are foreseen at **TissueAegis**, a young biomedical start up interested in the preservation of human cornea and the development of eye models to study the impact of drugs and conservations on the eye. Moreover, a collaboration is foreseen with the group of **Dr. Yannis Paulus at the Kellog Eye Center (Ann Harbor, USA):** medical (ophthalmological) scientists will provide access to a unique platform for the use of lasers in eyes of rabbits. This unique infrastructure will allow us to test toxicity and efficacy of our strategies *in vivo*.
Expected profile of the candidate	The doctoral candidate should be first highly motivated to work in the highly interdisciplinary field of nanomedicine. Preferably, the doctoral candidate should have a background in chemistry, biomedical sciences or pharmacy. A background in pharmaceutical chemistry would be important as pharmacokinetic studies are an essential part of the work. Background in the synthesis of nanomaterials would be of interest but it not completely essential. He/she should be fluent in English. Appropriate training will be provided by both PhD supervisors and institutions. He/she should be fluent in English to be able to communicate on a daily based with the people involved in the project
Application procedure	The application procedure is detailed on the European programme PEARL website www.pearl-phd-lille.eu. The funding is managed by the I-SITE ULNE foundation which is a partnership foundation between the University of Lille, Engineering schools, research organisms, the Institut Pasteur de Lille and the University hospital. The application file will have to be submitted before April 15, 2020 (10h Paris Time) and emailed to the following address : international@isite-ulne.fr.
Net salary and Lump Sum	A net salary of about €1,600 + €530 per month to cover mobility, travel and family costs.