UNIVERSITY OF GENOA
DEPARTMENT OF INFORMATICS, BIOENGINEERING, ROBOTICS AND SYSTEMS ENGINEERING
MASTER'S PROGRAM IN BIOENGINEERING

Dibris

Thesis Project Form

Title (tentative): Investigating the antibacterial effects of functionalized nanoparticles via atomic force microscopy

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Description

Motivation and application domain

Antibiotic resistance of bacteria poses a significant challenge in modern healthcare, driving the need for novel antimicrobial strategies.
Integration of quercetin (a plant flavonoid, has shown promising antibacterial properties) with polycaprolactone (PCL) nanoparticles, or the use of mesoporous bioactive glass (MBG) nanoparticles functionalized with bioactive ions such as copper and manganese, offer two promising approaches that could be also combined together.
AFM provides high-resolution imaging and mechanical property measurements at the nanoscale, making it an ideal tool to study the interactions between functionalized nanoparticles and bacterial cells.
This project aims to utilize atomic force microscopy as an innovative tool to analyse the antibacterial effects of PCL and MBG nanoparticles, functionalized with quercetin and/or with bioactive ions, against different bacterial biofilms, potentially leading to new approaches in antibacterial treatments.

General objectives and main activities

The main objective is to analyse the antibacterial effects of functionalised PCL and MBG nanoparticles- using atomic force microscopy (AFM) (https://www.bruker.com/en/products-and-solutions/microscopes/bioafm/jpk-nanowizard-4-xp-bioscience.html). The thesis work will focus on the following activities:
- synthesis of PCL nanoparticles functionalized with quercetin
- synthesize and functionalize MBGNs with copper, manganese, and quercetin.
- characterization of the physical and chemical properties of the functionalised nanoparticles.
- AFM imaging a nanoindentation measurements to detect the changes in surface topography and mechanical properties of bacterial cells/biofilms treated with the nanoparticles.
- tests of the effectiveness of functionalization procedures by comparing antibacterial effects of treatments with functionalized nanoparticles with the effects of treatments with non-functionalized ones

Training Objectives (technical/analytical tools, experimental methodologies)

The student will learn:
- techniques for nanoparticle synthesis and functionalization.
- how to operate an atomic force microscope for topography imaging and nanomechanical measurements
- methods for measuring nanomaterial-bacteria interactions
- data analysis technique to interpret AFM results and quantify antibacterial effects

Place(s) where the thesis work will be carried out: DIBRIS

Additional information

Maximum number of students: 2