INDUSTRIAL SOLUTIONS LABORATORY

Department Project Information

Department Name	*Mechanical Engineering and Engineering Science*	**Date Submitted**	*06/13/2022*
Project Title	*Design of a 3D printed drug delivery system for treatment of bone infection* **(BIO_BONE)**	**Planned Starting Semester**	*Fall 2022*

Funding

What is the source of funds that will be used to cover all direct costs of this project? _MEES Department

Is this source of funds already secured? Yes__X__ No____

Work Space

Have you secured a lab/work space for the project to be built? Yes__X__ No____

Faculty Mentor/Grading Instructors *

	Name	Email	Phone
1	Ahmed El-Ghannam	arelgha@uncc.edu	7-7730
2	Sujithra Chandrasekaran	schand25@uncc.edu	
3			

*List any graduate student that will be working on the project as a grading instructor so that they may be added to Canvas.

Senior Design Project Description

INDUSTRIAL SOLUTIONS LABORATORY

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project. Assume 10 hours per week per student.

Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills:

Discipline	Number	Discipline	Number
Mechanical	4	Electrical	
Computer		Systems	
Other ( )			

Project Overview:

Silicon carbide (SiC) is a strong material with high mechanical properties and chemical stability. Therefore, it can be used as a load-bearing bone implant. Surface activation of SiC promotes the bioactivity property which enables the material to deposit, in physiological solution, a hydroxyapatite layer on the material surface similar to the mineral phase of bone. Bone cells manage to absorb the calcium and phosphorus on the material surface and produce mineralized bone. During heating SiC discs, silica nanowires grow inside the pores making the material denser and stronger. The silica nanowires can serve as a carrier for drug and biological molecules. The objective of this project is to design a SiC drug delivery system that can serve as an implant to treat bone infection and augment bone. The students will learn how to 3D print SiC scaffold, grow silica nanowires inside the pores, characterize the nanowires, prepare antibiotic solution, load the SiC scaffold with antibiotics and analyze the release kinetics of the drug from the material.

Project Requirements:

SiC is inert material and difficult to process into 3D objects. To enable additive manufacturing of SiC the surface is chemically activated to create a 20-500 nm silica gel layer. The gel layer serves as a precursor for silica nanowires growth during heat treatment of the 3D printed SiC. In order to design a SiC drug delivery system, the 3D printed object has to bind antibiotic molecules and release it in a control fashion. The concentration of the released drug has to be within the therapeutic dose. Methods to increase the drug dose is by increasing the surface area available for drug binding. This can be done by increasing the density of the nanowires inside the pores of the 3D printed SiC scaffold.

Expected Deliverables/Results:

- Read the literature on antibiotic delivery systems.
- 3D printed SiC discs
- Thermal treatment to create various densities of nanowires

- Measure the mechanical properties
- Characterize the morphology, porosity, density, and mechanical properties
- Quantify the surface area of the scaffold before and after the growth of the nanowires
- Prepare antibiotic solution
- Load the 3D printed SiC with the antibiotic
- Measure the amount of antibiotic loaded
- Measure the release kinetics of the antibiotic in physiological solution

Disposition of Deliverables at the End of the Project:

A 3D printed SiC scaffold capable of antibiotic delivery

List here any specific skills, requirements, specific courses, knowledge needed or suggested (If none please state none):

- Materials Science and Engineering