



UNC Charlotte – Lee College of Engineering Senior Design Program Company Information

Company Name	Biomedical Engineering Concentration.	Date Submitted	11/15/2021
Project Title	Threading of SiC Composite Cylinders to Make Biocompatible Fixation Screws (BIO_SCREW)	Planned Starting Semester	Spring 2022

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

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	1	Electrical	1
Computer		Systems	
Other (BME concentration)	3		

Project Overview and Requirements:

Description of project and desired staffing.

Silicon carbide (SiC) is an inert material with excellent biocompatibility properties. A major issue that limits its use as a medical device is the difficult processing technique that requires hot pressing at a temperature ($>2,000^{\circ}\text{C}$) and pressure (1,000–2,000 atm). Previous studies in the lab have led to development of a protocol to synthesize a porous SiC scaffold by pressing the powder at 50 MPa and heating at $900^{\circ}\text{C}/2$ hr. The surface of SiC was chemically modified by NaOH to facilitate sintering and induce bioactivity. The objective of the present research project is to develop a protocol for synthesis of SiC fixation screws that can be used in orthopedic surgery. First, the students will mix SiC with mineral binders and use the mixture to make cylinders using two different methods; (i) powder metallurgy technique and (ii) 3D printing. The cylinders will be subjected to heat treatment in the temperature range $900\text{--}1400^{\circ}\text{C}$ to densify and strengthen the material. The students will determine the maximum shrinkage temperature of ceramic composite. The density, dimensional stability and mechanical properties of the cylinder will be measured. Second, the students will thread the cylinders in the machine shop and evaluate the quality of the threading using image analysis. Third, the students will evaluate the chemical stability of the cylinders/screws in physiological solution. The ceramic samples will be immersed in physiological solution and weight loss will be determined. Surface changes will be captured by electron microscopy.



Desired staffing: at least three students from BME concentration who understand 3D printing, creation of STL file and machining, one or two students who understand material's characterization.

Expected Deliverables/Results:

Deliverables include:

- Preparation of dense cylinders of SiC composite with minerals using additive manufacturing and powder metallurgy.
- Measurements of the dimensional stability, weight loss in physiological solution, density, and mechanical properties
- Threading the cylinders into screws

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

- Familiarity or interest in 3-D printing
- Understanding the effect of processing parameters on density (MEGR 3161 and or MEGR 3233)