Universidad de los Andes
Facultad de Ingeniería

Departamento de
Ingeniería Eléctrica y Electrónica

PRESENTACIÓN DE PROPUESTA DE PROYECTO O TESIS DE GRADO

FECHA: 19 de mayo del 2020

SEMESTRE: 2020-1

PROYECTO O TESIS DE GRADO PARA OPTAR EL TÍTULO DE:

Magister en Ingeniería Electrónica Y Computadores

ESTUDIANTE: Diego Felipe Martínez Valencia
CÓDIGO: 201615563
ASESOR: Johann F. Osma

TÍTULO DE LA TESIS O PROYECTO:

SIMULATIONS AND IMPLEMENTATION OF MAGNETIC MICROGRIPPERS FOR THE REMOVAL OF TEXTILE DYES IN WASTEWATERS

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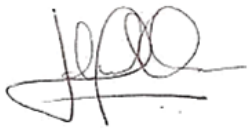

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TITLE (Thesis 1)

SIMULATIONS AND IMPLEMENTATION OF MAGNETIC MICROGRIPPERS FOR THE REMOVAL OF TEXTILE DYES IN WASTEWATERS

Keywords

Gripper, wastewater treatment, nanocomposites, surface functionalization

OBJECTIVES AND SCOPE

- **General**

  Simulation and implementation of biomechanical devices for the removal of textile dyes from wastewaters.

- **Specific (Tesis 1)**

  - Select materials and appropriate surface functionalization strategies to conduct textile dyes removal processes from wastewaters.
  - Engineer the geometry of selected materials with suitable capacity to be implemented in the microstructures.
  - Use software to simulate magnetic and mechanical responses of the microstructures and interactions among themselves.

INTRODUCTION

Water as an essential component to perform all human activities is a vital constituent of living organisms. However, the continued urbanization and population has had a high impact in the environmental development, diminishing potable water supplies and polluting oceans, aquifers, rivers, lakes, and groundwater at an unprecedented rate [1][2][3]. Some of the most common pollutants include pathogens, excess nutrients, suspended solids, sediments, pesticides, plastics, fertilizers, acids, detergents, phenols, minerals, and heavy metals which are discharged from homes, businesses, industry, cities, agriculture and the one we are focusing on this project is textile inks. [4][5][6].

As the world population increases, demands of clothing are increasing too, thus textiles are manufactured to meet the growing demands[7]. In some countries such as India; textile production becomes their source of income that contributes to their Gross

Domestic Product. However, this has brought both consequences to such countries having an improvement of economy, but with the negative impact attributed to environmental pollution[8].

The textile industries have been declared as the principal contributors of contamination, this can be justify in the way that they use more than 2000 types of chemicals and over 7000 types of dyes. Also, they produce heat send to the water and increase the pH of it. Among other consequences. Due to this, pollutants from the textile production sector are being released to the environment at various stages of operation. In addition, effluent or wastewater from textile production discharged to the water body without proper treatment also seep through the aquifer and pollute the underground water in many ways. Heavy metal constituents in the effluent also resulted in negative ecological impacts to the waterbody, environment as well as deterioration of human health [9][10].

Heavy metals in particular, lead, chromium, cadmium and copper are widely used for color pigments production of textile dyes. Those heavy metals also are present in the environment naturally. Although they are present in the structures of the factories and they are passively added to the dyes through protective agents used during storage [11]. These heavy metals which has transferred to the environment are highly toxic and can bioaccumulate in the human body aquatic life, natural water-bodies and also possibly trapped in the soil[12].
Textile dyes are being released to the environment at various stages of operation therefore it is necessary that the pollutants are removed by some techniques[13]. However, chemical interactions are no longer an environmental viable option. With that in mind, new techniques have to be developed in order to perform heavy metals and contaminants extraction, without increasing the addition of new chemical components to the environment.

APPROACH/METHODS

In this work we will be developing simulations of magnetic behavior of micro grippers for water contaminants extraction. Mostly the simulation of seemingly magneto-active elastomer composite structures for use in origami engineering applications.

The emerging field of origami engineering employs folding techniques, an array of crease patterns traditionally on a single flat sheet of paper, to produce structures and devices that perform useful engineering operations, like water contaminants removing. Effective means of numerical simulation offer an efficient way to optimize the crease patterns while coupling to the performance and behavior of the active material.

We well use for the simulation a range of functionalized materials, merged with magnetic and polymeric materials. Two methods of simulation will be used and modeled, one using the Maxwell stress tensor applied as a traction boundary condition and another employing a minimum energy kinematic (MEK) model. Both are based on actuation due to magnetic torque mechanisms that dominate MAE behavior.

Other analysis we will be developing is the interactions of those micro grippers with the environment related with chemical interactions, as well as pH and thermal changes.

Finite element analysis for this type of interactions and responses have to be done, a comsol multi-physics model to simulate blocking force of micro gripper fingers is the way to drive the simulations. In comsol Multi-Physics Model, the Structural Mechanics module, Electric Current module, Transport of Diluted Species module and General Form PDE module are used to simulate the behavior of micro gripper finger. Electric current module used to apply potential difference across electrodes. Transports of Diluted Species module explain the deflection due to transport of ions on applied voltage. Multi-Physics Finite Element tool is used to get reaction force for different potential differences and different parameters of gripper finger.

A number of simulations have to be done in order to select the optimal material for the real-life implementation of the grippers. Selection characteristics and parameters have to be declared having in mind the requirements and restrictions of the society. Material analysis and selection will be developed using and Appling clear room techniques, with controlled environments and amounts of contaminants.

The main goal and approach for this project is to select the optimal materials for the implementation of a functional micro grippers for water contaminants removal, using finite element analysis and clear room characterization techniques.

EXPECTED RESULTS AND DELIVERABLES

- Three different simulations for each material tested.
    - One for simple interaction of the gripper and natural magnetic behavior
    - One for study the behavior of a gripper with environmental changes as pH, temperature, among others.
    - One for the study of interactions between two or more grippers.
- Report of materials behavior and viability for real-life implementation
- One final selected material with all simulations and characterization.
- Optimal geometry chosen for the implementation of micro gripper. Thickness of the multilayer and material description.

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WORK PLAN

Thesis 1 and Thesis 2

		Activity	Week														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Thesis 1	1	Bibliographic Review																
	2	Materials and nanocomposites selection																
	3	Structure design and calculations																
	4	Materials surface functionalization																
	5	Software selection																
	6	Analysis of software simulation requirements																
	7	Test and simulations																
	8	Selection of optimal surface and design																
	9	Simulations of the optimar surface (microgripper)																
	10	Article 1																
Thesis 2	11	Evaluation of current work																
	12	Experimental design 1																
	13	microgripper implementation																
	14	Removal efficiency study																
	15	Mechanisms for recovery and reuse of materials																
	16	Results analysis																
	17	Article 2																

NECESSARY RESOURCES AND DATA SOURCES

Universidad de Los Andes has the necessary databases for the development of this thesis.

The Department of Electrical and Electronic Engineering has laboratories equipped with instruments for measurement-visualization and generation of electrical variables (PXI-Labview Module, single-dual voltage source, Multimeters and IR Thermometer). Additionally, the Department owns a clean room for the manufacture and synthesis of materials in controlled environments of reduced atmospheric particles, humidity and temperature. With lithography capabilities, deposition of metallic and dielectric films and packaging processes.

The equipment for spectroscopic, microscopic and electronic characterization, FTIR, AFM and SEM and the equipment for particular quantification, ZETASIZER NANO can be found at the University´s microscopy facility, laboratory of the chemical engineering department and laboratory of the biomedical engineering department.

Software requirements for finite elements analysis as COMSOL Multiphysics. As well as software for computing among other simulations (Matlab, Labview, altium, Ansys electromagnetics)

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