

An Indian-Australian research partnership

Project Title: **Mechanics of Smart Soft Biomaterials**

Project Number **IMURA0909**

Monash Main Supervisor
(Name, Email, Phone) **Santiago Badia, santiago.badia@monash.edu** *Full name, Email*

Monash Co-supervisor(s)
(Name, Email, Phone) **NA**

Monash Head of Dept/Centre (Name, Email) **Prof. Kais Hamza, sci-maths-headofschool@monash.edu** *Full name, email*

Monash Department: Department of Mathematics

Monash ADGR
(Name, Email) **Prof. Peter Betts, peter.betts@monash.edu** *Full name, email*

IITB Main Supervisor
(Name, Email, Phone) **Alankar Alankar, alankar.alankar@iitb.ac.in** *Full name, Email*

IITB Co-supervisor(s)
(Name, Email, Phone) **NA** *Full name, Email*

IITB Head of Dept
(Name, Email, Phone) **Prof. Bhalchandra Puranik, head.me@iitb.ac.in** *Full name, email*

IITB Department: Department of Mechanical Engineering

Research Clusters:

Research Themes:

1	Material Science/Engineering (including Nano, Metallurgy) Energy, Green Chem, Chemistry, Catalysis, Reaction Eng	1	Advanced computational engineering, simulation and manufacture
2	Math, CFD, Modelling, Manufacturing	2	Infrastructure Engineering
3	CSE, IT, Optimisation, Data, Sensors, Systems, Signal Processing, Control	3	Clean Energy
4	Earth Sciences and Civil Engineering (Geo, Water, Climate) Bio, Stem Cells, Bio Chem, Pharma, Food	4	Water
5	Semi-Conductors, Optics, Photonics, Networks, Telecomm,	5	Nanotechnology
6	Power Eng	6	Biotechnology and Stem Cell Research
7	HSS, Design, Management	7	Humanities and social sciences
8		8	Design

The research problem

Soft and stretchable materials can go through large and quick deformations. These materials find applications in smart biomedical devices e.g. soft robots for drug delivery. In some of the applications the soft materials need to maintain the shape after the actuation. The required shape-programmability can be achieved for soft materials with high coercivity. Such materials can not only go through large deformations but can also retain it even after the stimulating magnetic field is turned off. Nonlinear finite deformation has been studied for many decades. However finite deformation actuated by magnetic field is a much newer problem and has wide applications. In this project we intend to develop a numerical

framework based on mechanics of a hard magnetic soft material in presence of magnetic field.

Project aims

1. Develop constitutive framework for actuation of hard magnetic-soft material
2. Numerical algorithms for finite deformation – magnetic field coupled models and their implementation
3. Validation using test cases available in literature
4. Design use cases that be validated by experiments in subsequent projects

Expected outcomes

1. A constitutive framework for mechanics of magnetic actuation of soft material
2. A simulation tool for coupled finite strain-magnetic actuation

How will the project address the Goals of the above Themes?

The project applies Advanced Computational Engineering for Biomedical applications. It falls in the category (1) and (6).

Capabilities and Degrees Required

An ideal candidate should have a BTech or BE or Master in Mechanical Engineering, Aerospace Engineering, Civil, Mathematics or Physics, with a strong inclination towards advanced mathematics, numerical methods, continuum mechanics, non-linear elasticity. Experience in at least two of the following three criteria is desired: 1. Background in mechanics of materials; 2. Expertise in numerical methods for PDEs (finite element methods); 3. Expertise in programming (Python, C, C++, Fortran, Julia, etc)

Potential Collaborators

Jerome Droniou (expert in numerical methods for PDEs, jerome.droniou@monash.edu)
Ricardo Ruiz-Baier (expert in numerical methods for PDEs, ricardo.ruizbaier@monash.edu)
Raghunath Chellakot (Soft Matter, raghu@phy.iitb.ac.in)
Neela Nataraj (Finite Element Method, neela@math.iitb.ac.in)
We will also look for collaborators in Chemical Engineering or Bio Sciences and Engineering for experimental validations.

Select up to **(4)** keywords from the Academy's approved keyword list (**available at <http://www.iitbmonash.org/becoming-a-research-supervisor/>**) relating to this project to make it easier for the students to apply.

Soft Matter, Soft Robots, Smart Biomaterials, Computational Fluid Dynamics and Mechanics