Engineering and Innovation Research Studentship
October 2020

Project title:	Carbon dioxide capture using algal hydrogels
Discipline	**Biomaterials; biotechnology; energy; environment**
Key words:	Biomaterials; carbon dioxide; environment
Supervisory team:	**James Bowen (E&I); Carl Boardman (E&I); Nicholas Power (LHCS)**
URL for lead supervisor's OU profile	**http://www.open.ac.uk/people/jb36559**

Project Highlights:

- Excess carbon dioxide in the atmosphere is linked to climate change.
- Low carbon methods of carbon dioxide removal are highly sought after.
- Algae remove atmospheric carbon dioxide and create valuable photosynthetic by-products.

Project Description:

Photosynthetic seaweed species play a vital role in capturing carbon across the Earth, producing up to 90% of global oxygen in the process. It is estimated that 35M km^2 of the ocean surface, covered in algae, would capture the entire annual global carbon dioxide output. Reducing the carbon dioxide content of the atmosphere is seen as a preferred method for reducing the impact of global warming.

Using natural biotechnologies such as algae in novel ways may provide engineering solutions to climate change. Mitigating technologies for reducing the forecast global temperature rises are highly sought-after. This project seeks to address the problem of carbon dioxide capture using three-dimensional hydrogels, rather than a two-dimensional air/liquid interface, e.g. the ocean surface. This will greatly reduce the land or ocean surface which is required to implement carbon dioxide capture.

Research Methods:

This project will explore the encapsulation and viability of different types of algae within a hydrogel matrix. The preferred matrix candidate is an alginate hydrogel, which is derived from seaweed, an environmentally sustainable material available in large quantities for low cost. Encapsulation should allow a healthy population to be sustained, preventing the onset of damaging over-proliferation which precedes biofouling.

The effects of environment on algal viability will be investigated, including salinity, pH, temperature, light intensity, and the duration of light/dark cycles. The synthetic by-products released by the algae, as well as the rate of oxygen production, will be analysed. It is expected that those compounds that diffuse out of the hydrogel can be separated during downstream processing as solids or liquids. Hence, the carbon dioxide has been removed from the atmosphere, and the photosynthetic product can be safely stored.

Indication of project timeline:

Year 1: Photosynthetic efficiency of different types of algae.
Year 2: Encapsulation and viability studies.
Year 3: Optimising hydrogel geometries for carbon dioxide utilisation.

Background reading:

[1] Kaklamani, G.; Cheneler, D.; Grover, L.M.; Adams, M.J.; Anastasiadis, S.H.; Bowen, J.; Anisotropic dehydration of hydrogel surfaces, *Prog. Biomater.*, **2017**, *6*, 157-164.

[2] Kaklamani, G.; Cheneler, D.; Grover, L.M.; Adams, M.J.; Bowen, J.; Mechanical properties of alginate hydrogels manufactured using external gelation, *J. Mech. Behav. Biomed. Mater.*, **2014**, *36*, 135-142.

[3] Schilp, S.; Rosenhahn, A.; Pettitt, M.E.; Bowen, J.; Callow, M.E.; Callow, J.A.; Grunze, M.; Physicochemical properties of (ethylene glycol)-containing self-assembled monolayers relevant for protein and algal cell resistance, *Langmuir*, **2009**, *25*, 10077-10082.

Candidate Applications:

Students should have a strong background in materials, chemistry, engineering, biology, or environmental sciences, coupled with an enthusiasm for discovery and innovative thinking. The student will join a well-established group which explores fundamentals and applications of materials engineering at the Open University.
Please contact **James Bowen** for further information (**james.bowen@open.ac.uk**).

Applications should include:

- A 1000 word cover letter outlining why the project is of interest to you and how your skills match those required
- An academic CV containing contact details of three academic references
- Open University application form
- Applicants will need to demonstrate good competence in the English language. To be eligible for a full award, a student must have no restrictions on how long they can stay in the UK and have been ordinarily resident in the UK for at least 3 years prior to the start of the studentship.

Applications should be sent to **STEM-EI-PhD@open.ac.uk** **by 31.03.20**