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Scalable engineering approaches for exploiting a novel biocomposite material applied to light-driven CO_2 absorption and utilization

With carbon dioxide accounting for more than 90% of the gaseous emissions to the environment in the past three decades and the Chemical Industry being a large CO_2 emissions contributor, it is necessary to develop more efficient technologies which are able to effectively capture and utilise CO_2 to close the carbon loop. Mitigation of climate change and reducing our reliance on fossil-based resources through the use of bio-based, renewable resources to convert the CO_2 are two attractive propositions of this endeavour.

The proposed project seeks to develop efficient and sustainable bioprocess engineering approaches for CO_2 capture and its utilisation as a sustainable feedstock using photo-sensitive biocatalysts immobilized in a biocomposite structure. The biocomposite material represents a new generation of intensified, highly reactive and stable biocatalysts that absorb and metabolise CO_2 and other small carbon molecules into more benign, useful products in the presence of light. The revolutionary dry-stabilized biocomposite materials offer tremendous opportunities to intensify conversion efficiencies, minimize energy input for mass transfer and significantly reduce water use. The two engineering approaches selected for investigation are based around process intensification concepts of a thin film spinning disc surface operating in continuous mode, with capability for significantly enhanced gas-liquid transfer of CO_2 and electrochemical processing concepts for greater CO_2 conversion efficiency. The intention in applying these engineering approaches is to enable CO_2 capture and conversion technologies to become more industrially viable, especially at larger processing scales.

This project has a sustainable engineering focus contributing to sustainability and social renewal via the reduction of carbon emissions and the development of technologies that can support a bio-economic framework.

If successful, the proposed technologies will enable many different types of microbial biotransformations of waste carbon gases at industrial scales with applications to valorization of not only CO_2 but also syngas (CO), biogas (CH_4), and volatile organic carbon (VOC) pollutants. This will result in potentially huge beneficial implications for provision of clean air while converting the waste carbon into valuable commodity chemicals.