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CARES Visiting Scientist Seminar Series:

Sunlight-driven circular economy for a sustainable future: (Photo) electrochemical systems and 'artificial leaves' for waste-to-fuel/ chemical production

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Thursday 12 January 2023, 4pm - 5:30pm

Pinnacle Room, Level 16, CREATE Tower

C4T — Cambridge Centre for Carbon Reduction in Chemical Technology

Abstract: The use of sunlight-driven technologies to utilise abundant solid waste resources and greenhouse gases like CO_2 as feedstocks for the generation of sustainable fuels and value-added chemicals emerges as a lucrative strategy to mitigate environmental pollution, tackle our energy crisis and create a circular economy. However, the existing solar waste conversion systems are not yet suitable for practical applications owing to their low efficiencies, poor product selectivity, lack of versatility and non-reusability.

We introduce (photo)electrochemical (PEC) platforms that can reform a diverse range of waste streams, including biomass, industrial by-products, and plastics, into industrially relevant value-added chemicals and clean fuels simultaneously without any externally applied bias/voltage. Along with reforming solid waste streams, the PEC systems can produce fuels such as green hydrogen and convert atmospheric CO_2 from compressed or captured sources to syngas, CO or formate. The systems achieve 60–90% product selectivity and >100 µmol cm^{-2} h^{-1} product formation rates, which corresponds to 102–104 times higher activity than conventional particulate photoreforming systems. The solar-driven, single-light absorber PEC devices are versatile and can be assembled in either a 'two-compartment' or integrated 'artificial leaf' configurations, with each having its specific advantages. The proto-type device demonstrates the potential of PEC assemblies towards waste valorisation, accompanied by sustainable fuel production, approaching the thresholds required for commercial implementation.

Biography: Subhajit Bhattacharjee received his integrated bachelor's and master's (BS–MS) degree in chemical sciences from the Indian Institute of Science Education and Research (IISER) Kolkata, India in 2019 and is currently pursuing his PhD under Prof Erwin Reisner at the University of Cambridge, UK. His research broadly lies in the domain of materials and energy sciences, and primarily focuses on the design, development, and engineering of solar and electro-driven technologies for sustainable energy production, waste valorisation, and CO_2 utilisation. Some of his projects include: building efficient photoelectrochemical devices and 'artificial leaves' for selective waste-to-fuel/chemical production, bio-electrocatalytic olefin generation, chemoenzymatic photoreforming of plastics, and solar-driven CO_2 capture and conversion, among others.

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