Environmental Research, Technology Demonstration and Conference Project

ECF Project:	ECF 2020-79
Project Title:	Development of efficient and robust photocatalysts for hydrogen production technology for reducing fossil fuel consumption and emissions
Principal Investigator:	Dr Ho Cheuk Lam, Department of Applied Biology and Chemical Technology, The Hong Kong Polytechnic University
Total Approved Grant:	$500,000
Duration:	1/8/2021 to 31/7/2023
Project Status/Remarks:	Completed
Project Scope:	Carbon-dioxide is the main cause of human-induced global-warming and associated climate change. Promotion of renewable energy will help to reduce carbon-emissions and other pollutants originating from burning of fossil-fuels and subsequently improve air-quality. Solar-driven water-splitting into hydrogen using photo catalysts is very appealing to produce clean, storable and renewable fuels. Although extensive efforts have been paid in investigating new photo catalytic system solely based on semiconductor-based catalysts, their limited tunability in optical/electronic properties, insufficient-stability and low-efficiency in aqueous environment still remain a challenge. The search for efficient and scalable photo catalysts for water-splitting remains the most challenging task for solar-energy utilisation. In this proposal, a series of supra molecular assemblies comprising of redox-active and/or light-harvesting coordination molecular cages with encapsulating organic-photosensitiser will be explored as photo catalysts for photo stable and highly-active photo catalytic systems for hydrogen-generation from water. These assemblies are easily to be prepared in large scale by metal-directed self-assembled methods by reacting alkylated sulfonylcalixarenes with functionalised carboxylate ligands. Solar-light-mediated water-splitting will be achieved by using photo catalytic-reactor wherein particles of assemblies photo catalyst suspended in water act as micro-photo electrodes, and facilitate water-reduction on their surface. Optimisation of the photo catalytic systems will be garnered through systematic variation of assemblies' structures and device components (e.g. pH, concentration, etc.).
Summary of the Findings/Outcomes:	Photocatalytic water-splitting by solar-light has received tremendous attention for the production of clean and renewable hydrogen energy from water. Even though the past decades have witnessed intensive research into inorganic semiconductor photocatalysts, the quantum efficiencies for hydrogen production from visible photons remain too low for the deployment of this technology. To overcome the obstacle of low photocatalytic efficiency, one of the good ways is the development of new photocatalytic materials. Molecular photocatalytic materials offer the advantages of chemical and photochemical versatility. Serveal series of molecular photocatalytic meterials, including metal-organic cages, organic

	dyes with starburst structures, robust cyclometalated iridium (III) and ruthenium(II) complexes with different electron donors, have been developed for photocatalytic hydrogen production in pure water. All these studies clearly stated that by the optimization of the photocatalysts' component thorough systematic variation of the donors/ π -bridges/acceptors/anchoring groups and other substituents are greatly omportant for the long-term activity and stability bottlenecks of current water-splitting hydrogen-production systems and to develop energy-efficient, cost-effective, durable and environmentally benign photocatalytic systems for hydrogen-production.