Innovative Photocatalytic Materials to Enable Global Accessibility to Clean Water

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Every day, ~5000 children die due to lack of clean water. Clean and potable water access is a human right and a pillar of the United Nations’ Sustainability Goals. Photocatalytic technologies, where a catalyst promotes destruction of organic water-borne pathogens, have emerged as potential cost-effective purification technologies. These technologies can improve pure water accessibility in both developed and developing areas. Pure and doped TiO2 photocatalysts have been the main focus of work to date. However, these are associated with problems such as cost, low activity (particularly in visible light), complex processing and separation methods, limited wavelength range for effective use and poor availability in remote areas. This work focuses on the development of new transition metals and organic polymers to improve photocatalytic performance and use. Catalytic activity was tested under a range of conditions (pH, dark adsorption, light intensity, concentration of pollutant, concentration of photocatalyst, etc.) for degradation of methyl orange, methylene blue and phenolphthalein. The data reveals that hitherto unexplored copper materials provide disruptive advances in photocatalyzed pollutant destruction, notably providing high activity under visible light. The results are compared to other materials through a comprehensive review and analysis of literature. The work challenges assumptions in the literature and provides new understandings of kinetics and mechanisms of degradation. This work shows that the copper materials developed have the highest activity and stability measured to date and the analysis of data allowed the design of a simple and effective reactor for water purification in remote environments.