The 109th GREEN Seminar

Catalysts design, mechanistic studies and degradation for electrochemical oxidation and reduction processes

Chair: Dr. Ken Sakaushi (GREEN)

Prof. Magda Titirici

(Imperial College London, Department of Chemical Engineering, UK)

To mitigate the climate change and reach a carbon neutral society before it is too late, a mix of sustainable energy technologies are needed. In this talk I will present research from my group in the area of green H_2 from the electrolysis of biomass derivatives as well as fuel cells free of Pt electrocatalysts for the cathodic reaction.

Green H_2 is also a key energy vector helping our transition to net zero. Green H_2 is commonly obtained from water electrolysis using various membranes such as alkaline, proton conductive, anion exchange or solid oxides. While the cathodic hydrogen evolution reaction happens with a minimum amount of Pt (> 0.05 mg/cm^2) and with a low overpotential (η_{HER} ~ 0.01V at 1.4 V), the anodic oxygen evolution reaction is sluggish and requires large amounts of IrO_x, a critical mineral, (<0.3mg/cm^2) at high overpotentials (η_{OER} ~ 0.4V). I will present our research on new substates for electrocatalytic H_2 production based on biomass/plastic waste derivatives such as glycerol, ethylene glycol or 5-hydroxymethylfurfural with advantages in terms of lower potentials where the biomass/waste oxidation reactions occur and the advantages of producing other high value chemicals in addition to green H2, helping a circular economy.

I will also touch on the use of H_2 in fuel cells for zero carbon electricity production. The sluggish reaction here is the oxygen reduction reaction happening at the cathodes requiring Pt catalysts which are scarce and expensive. I will present research on bioinspired catalysts based on Fe single atoms coordinated to nitrogen atoms doped on a conductive carbon matrix and their activity emphasising the importance of determining the number of active sites, turnover frequency and understanding the issues hindering the stability of such catalysts.

Venue: Auditorium, 1F, NanoGREEN/WPI-MANA Bldg., Namiki-site

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Contact: SAKAUSHI.Ken@nims.go.jp