Combined biomass valorization and hydrogen production in (photo)electrochemical cells

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Photocatalysis, photoelectrocatalysis

Concept (max 1000 characters)

In recent times, there's been a significant shift in energy generation methods due to resource depletion, climate change, and pollution. Green hydrogen production, notably through water electrolysis, is crucial for transitioning to sustainable energy. Challenges include developing platinum group metal (PGM) free catalysts to reduce energy-intensive processes and improving Oxygen Evolution Reaction kinetics. Introducing biomass as a competing solution species can lower energy consumption during electrolysis, yielding valuable molecules for various industries. Photocatalytic (PC) and photoelectrocatalytic (PEC) methods, offer a mild and potentially sustainable approach, especially when coupled with renewables energy.

Scientific approach (max 1000 characters)

PC and PEC oxidation offer a promising method, combining renewable feedstock and green energy for chemical and fuel production simultaneously. In both systems, photoinduced electrons (e^-) and holes (h^+) facilitate reduction and oxidation reactions.
In PC systems, e^- and h^+ migrate to the photocatalyst surface, while in PEC systems, an applied electric field prevents their recombination, with electrons moving to the cathode and holes to the photoanode surfaces. Achieving high selectivity for desired products and, in PEC systems, high faradaic efficiency (FE) are major challenges.
Among the available photoanodes, TiO_2 stands out as the preferred photoanode due to its high activity, stability, scalability, low cost, and non-toxicity. On the cathode side, using PGM-free materials with stability and low overpotential for H_2 generation is crucial for cost reduction.

Research objectives (max 500 characters)

- Scale up the from a PC batch configuration to a flow through PEC system
- Tuning of the h^+ oxidation level in order to enhance the selectivity of high value added products
- Improve the cell design to allow to raise the output gas pressure.
- Use PGM free materials
- Use chemically and physically stable materials, i.e., reuse the electrodes after a proper cleaning step