Introduction and objectives

Producing H₂ from the photo-electrochemical conversion of urea requires in theory three times less energy than from water splitting, (thermodynamic $E_{cell}$ of 0.37 V vs. 1.23 V, respectively). The vast un tapped resource of urea in urine (60 Mt/year from humans) makes this reaction very attractive. Thereby, converting pollutant into fuel with the assistance of solar energy simultaneously addresses the issues of (1) wastewater treatment, (2) production of H₂ as an energy vector and (3) energy saving by employment of renewable energies.

Urea electro-oxidation has been the subject of numerous studies [1] but only three works have been published on the photo-electro-oxidation of urea [2-4] and this research appears promising. It is usually performed in alkaline media with Ni based catalysts.

In this context, our goal is to design and study photoanodes for efficient conversion of solar energy (UV-Visible) to obtain high urea density.

### H₂ Photoproduction - Principle

- **FTO/Fe₂O₃/Ni** materials for the photo-electrochemical conversion of urea with H₂ production

### Electrodeposition of Fe on FTO

- Cathodic deposition under cyclic voltammetry:
  - 5 cycles at 5 mV/s in 10mM FeCl₂ + doping KCl 0.1M
  - Tests in NaOH 1M under Ar, in the dark or under illumination.

### Fe₂O₃ layer characterization

- **SEM**
- **X-Ray Diffraction**
- **Photoelectrochemical response (water oxidation) and doping**
  - Best result obtain with Fe₂O₃ doped by 0.5%Sn:
    - 0.44 mA/cm² at 0.55V/SCE
    - 0.88 mA/cm² at 1000 W/m²
  - Sn doping improves the photocurrent and the onset potential for water oxidation

### Urea PEC oxidation with Nickel catalyst

- **Ni electrodeposition**
  - 0.03M NiSO₄ + 0.2M NaCl, pH=8
  - 1.1V/SCE during 60s
- **PEC performances**
- **Tests in 0.1M urea + NaOH 1M under Ar**
  - in the dark or under illumination

### Conclusion

Hematite has been synthesized and doped using EC methods only.

Doping α-Fe₂O₃ with Sn significantly improves the onset potential and photocurrent. The designed FTO/Sn:Fe₂O₃/Ni photoanodes are efficient for urea PEC oxidation.

A significant gain in potential (-200 mV) at low current density is obtained with urea vs. water oxidation. These are preliminary results with a lot of room for improvement.

### References