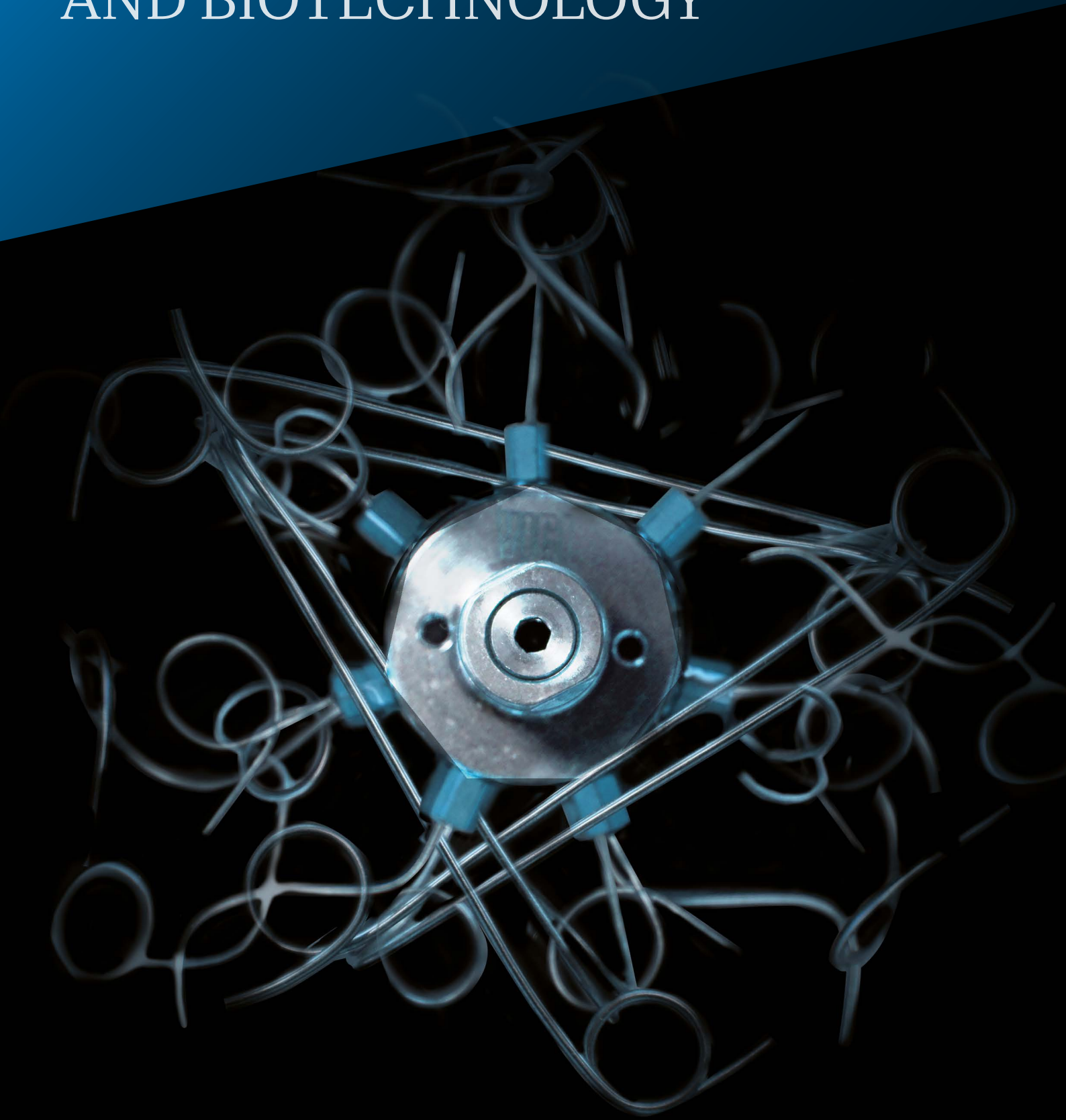
MASTER

# CHEMICAL ENGINEERING AND BIOTECHNOLOGY



EPFL

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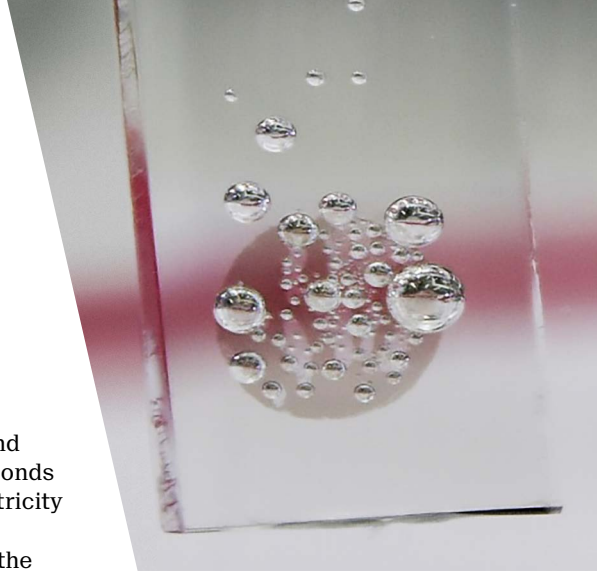
## Innovative, better, safer and eco-friendly

Scaling up from a laboratory reaction to an industrial process is the main challenge for chemical engineers. This is a complicated optimization problem at many levels: environmental impact, energy consumption and cost must be minimized and the quality and process safety maximized.

# Hydrogen Production using a MoSx Catalyst on $Cu_2O$ Photocathode



*Chemistry of H2 for Energy*

Carlos Morales

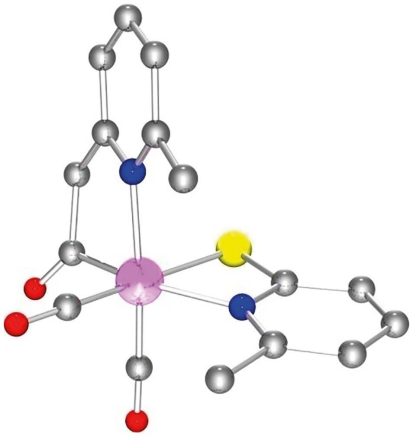
"We are looking for different ways to transform sunlight into solar fuels. More specifically, we are interested in splitting water to produce hydrogen and oxygen using sunlight. The energy stored in the form of new hydrogen bonds created during the day can, for example, be used to generate electricity during the night.

Essentially, the splitting of water requires coupling in the same device of light absorbing materials with efficient electrocatalysts. The best hydrogen evolving electrocatalysts are precious metals like Platinum which, however, are expensive and scarce.

This work brought together a light absorbing cuprous oxide developed in the Prof. Graetzel's group with a very efficient molybdenum sulfide electrocatalyst developed in Prof. Hu's group. The combination for the first time of these two materials in the same device allowed us to demonstrate efficient hydrogen production using sunlight. Moreover, the device was prepared through scalable manufacturing techniques and sets a new benchmark of efficiency for photoelectrodes using only abundant elements for both the light absorbers and hydrogen evolution electrocatalyst."

**Watch the video:**

*Andrés López:*
*"When you are at EPFL, you are in contact with the best research that is being done right now. You are here with scientists that are building the future of science."*



# Characterization of disperse Dyes and Application Properties in Inks for Ink-jet Printing

*Delphine Blondel:*
*"The Master gives you the chance to choose between different options, and I went for biotechnology and food industry. Currently, I am carrying out an industrial internship as a health and security engineer. I establish organizational strategies to store hazard liquids. The risk management and safety of chemical processes classes at EPFL prepared me to work in that field."*

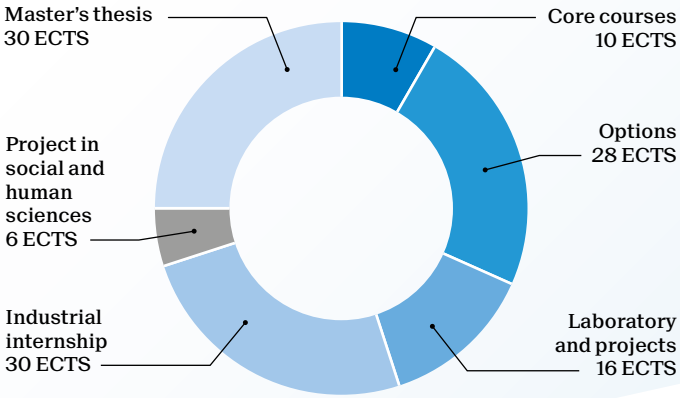
Marion Debellemanière

The research is aimed on the investigations of the differentiating properties between specific lots of disperse red ink. This dye is used for transfer printing on polyester fabrics in the imaging industry. Some lots presented problematic properties that caused specific problems like the blocking of the nozzles in the piezoelectric drop-on-demand printing heads and the inability to reduce the particle size to a model size smaller than 150 nm in the milling step. Theses differentiating properties between the lots that presented problems and those that presented satisfactory performances have been researched and attempted to be identified. Some solutions to improve the use of these inks have been investigated. The presence of unexpected magnetisable material identified as iron has been expected to be the potential problematic factor. To achieve the goal of differentiating the lots, the first approach proposed to quantify this iron in the lots. Then, the physico-chemical properties of the lots have been investigated with a critical micelle concentration study to see if the problems encountered during the milling process were due to wettability differences. The set-up of a blind test aimed to estimate the quality of a lot has completed these researches. Finally, further characterization experiments have been performed by Nuclear Magnetic Resonance and X-Rays crystallography.

Master of Science in

# CHEMICAL ENGINEERING AND BIOTECHNOLOGY

2-year program - 120 ECTS




**Students may opt for a 30 ECTS catalysis/sustainability specialization. In this case, 18 ECTS of specialization labeled courses must be taken on top of the core courses and the chemical engineering lab and project.**

| | Spec. | Credits |
|---|---|---|
| **Catalysis/sustainability core courses** | | **8** |
| Automated and data-driven laboratories | ● | 2 |
| Sustainable chemicals manufacture: concepts/tools | ● | 4 |
| Sustainable chemistry and chemical engineering in Industry | ● | 2 |

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|---|---|---|
| **Options** | | **18** |
| Catalysis | | |
| Advanced nuclear magnetic resonance | ● | 3 |
| AI for chemistry | ● | 2 |
| Asymmetric catalysis for fine chemicals synthesis | ● | 3 |
| Catalyst design for synthesis | ● | 2 |
| Machine learning for physicists | ● | 4 |
| Optical methods in chemistry | ● | 3 |
| Sustainability | | |
| Environmental Economics | ● | 4 |
| Environmental system analysis and assessment | ● | 5 |
| Fate and behaviour of environmental contaminants | ● | 4 |
| Introduction to ethics and critical thinking | ● | 3 |
| Legal aspect of sustainabilty & digitalization | ● | 5 |
| Science of climate change | ● | 4 |

**Students may also opt for a 30 ECTS minor instead of the industrial internship.**
**Recommended minors:**

- Engineering for sustainability
- Materials science and engineering
- Physics

| | Spec. | Credits |
|---|---|---|
| **Core courses** | | **10** |
| Chemical engineering | | |
| Diffusion and mass transfer | | 4 |
| Heterogeneous reaction engineering | ● | 4 |
| Management and safety | | |
| Safety of chemical processes | ● | 2 |

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| **Options** | | **28** |
| Theme A: Energy | | |
| Catalysis for emission control and energy processes | ● | 3 |
| Catalysis for energy storage | ● | 3 |
| Electrochemical engineering | ● | 3 |
| Modeling and optimization of energy systems | | 4 |
| Nanomaterials for chemical engineering application | | 3 |
| Process intensification and green chemistry | ● | 3 |
| Solid state chemistry and energy applications | | 3 |
| Thermodynamics of energy conversion and storage | | 3 |
| Theme B: Biotechnology | | |
| Bioprocesses and downstream processing | ● | 4 |
| Biotechnology lab (for CGC) | ● | 4 |
| Food biotechnology | | 2 |
| Nanobiotechnology | | 3 |
| Pharmaceutical biotechnology | | 3 |
| Principles and applications of systems biology | | 3 |
| Selected topics in life sciences | | 3 |
| Synthetic biology | | 4 |
| Theme C: Materials and food engineering | | |
| Chemistry of food processes | | 2 |
| Chimie des denrées alimentaires | | 2 |
| Entrepreneurship in food & nutrition science | | 4 |
| Food biotechnology | | 2 |
| Organic electronic materials | | 4 |
| Physical and chemical analyses of materials | ● | 3 |
| Physical chemistry of polymeric materials | | 3 |
| Polymer chemistry and macromolecular engineering | | 3 |
| Risk management | ● | 2 |
| Solid state chemistry and energy applications | | 3 |
| Sustainability and materials | ● | 3 |

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| **Laboratory and projects** | | **16** |
| Chemical engineering lab and project | ● | 4 |
| Chemical engineering product design | | 4 |
| Process development | | 8 |

School of Basic Sciences
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