The Hensen group focuses on the generation of scientific and technological knowledge in the field of catalyst systems relevant to the development of clean and sustainable processes for the production of fuels and chemicals. Modern concepts of catalysis are used to design catalysts to process current and future feedstocks in an as sustainable manner as possible with minimum environmental burden and energy consumption. Focus is on the synthesis of complex catalyst systems containing well-designed catalytically active ensembles and structured at various length scales to optimize reaction and diffusion. Applications are directed towards the improvement of current industrial processes, implementation of transition technologies involving natural gas and the development of novel catalytic processes based on renewable feedstocks such as biomass and carbon dioxide.

The work is structured around four themes:

**Structure Sensitivity**

Structure-activity relations are crucial in heterogeneous catalysis because they enable the design of improved catalysts. Emphasis is on the understanding of reaction mechanism. These studies combine computational catalysis, in situ spectroscopy (XAS, IR, Raman) and kinetic modelling (experimental kinetics, microkinetic modelling). Catalytic reactions of interest are alkane activation, (selective) oxidation, steam reforming and Fischer-Tropsch synthesis. Topics of interest are the influence of nanoparticle size and shape on catalytic performance for these reactions.

**Porous Materials**

Microporous and mesoporous materials are of utmost importance to the chemical industry. The group works on obtaining fundamental understanding of the principles underlying the assembly of porous materials with a special focus on the hierarchical structuring and formation of well-defined active sites. In this way, hierarchical zeolites tuned to specific applications are aimed for. The work includes experimental and theoretical studies of Brønsted and Lewis acidity in zeolites and other porous materials. Applications are mainly in the field of petrochemistry and biomass processing.

**Biomass Valorization**

Biomass is an attractive renewable feedstock with the high potential for the production of a wide range of useful chemicals. Its efficient utilization requires the development of novel highly selective catalytic processes for processing biomass components. The group works on the development of molecular level understanding of catalytic chemistry of biomass using a complementary approach combining theory and experiment. These studies provide with novel catalysis concepts that support the activities aimed at the development of novel sustainable catalytic routes for valorization of lignocellulose biomass.
**Solar Fuels**

Direct utilization of sunlight to drive chemical reactions such as water splitting remains a considerable challenge. If successful, it will provide a direct route to store solar light into chemical bonds. Photocatalysts consist of a photoadsorber and catalytic particles on their surface which drive oxidation and reduction reactions. The work at IMC focuses on novel inorganic semiconductors to harvest light and efficient co-catalysts for water splitting. Studies include mechanistic, spectroscopic and theoretical studies of model systems with the aim to generate fundamental knowledge essential to design better catalysts. Part of the work is done in close collaboration with the Applied Physics department, where students can use advanced techniques such as atomic layer deposition.

**Courses**

Students interested in catalysis can follow these courses:

- Catalysis: Chemistry and Technology
- Modern Concepts in Catalysis
- Advanced Inorganic Chemistry

Excellent BSc students interested in the field of photocatalysis can register for the interuniversity Solar Fuels Catalysis graduate programme between Eindhoven University, Utrecht University, Leiden University and Twente University. More information of this combined MSc/PhD programme is available via Emiel Hensen.

**Internships or graduation projects**

We are always looking for enthusiastic master students who wish to participate in the various research projects in our group. For a detailed description of projects please have a look at the research projects of our Ph.D. students and post-doctoral researchers.

More information about the group Inorganic Material Chemistry: [www.catalysis.nl/imc](http://www.catalysis.nl/imc)

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