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Fuels and Catalysis

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The energy consumed worldwide comes essentially from fossil fuels (oil, coal, natural gas). This will lead in the future to ecological damages, inter alia as a result of CO_2 release in the atmosphere. Hydrogen represents a clean and carbon-free energy vector, which can be converted to electrical energy by fuel cells. Therefore, hydrogen is foreseen as tomorrow's energy carrier. A mass-production of hydrogen is a challenge for catalysis. Nowadays, catalytic steam reforming accounts for 85% of world's hydrogen production, the rest being produced through partial oxidation, coke gasification or water electrolysis. For stationary applications, fossil fuels could be utilised when associated with CO_2 sequestration. For mobile applications like fuel cells-powered electric cars, on-board hydrogen generation from gasoline is also foreseen, at least as a transition period.

The overall process for hydrogen production from hydrocarbons requires a complex reaction chain to obtain the high-purity hydrogen which is needed by a proton exchange membrane fuel cell. Highly dispersed noble metal particles, coated on both sides of the membrane (e.g. Pt), act as a catalyst. Apart from the reformer, several subsequent catalytic reactions have to be performed to decrease the CO content below 10 ppm, to avoid poisoning of the catalyst in the fuel cell.

Hydrogen will not replace oil before several decades: the current hydrogen production represents less than 1% of the world energy consumption. Catalysis is currently highly involved in refinery, petrochemistry, hydrotreating, etc. The catalysts have to be characterized by several physical techniques and their performances have to be evaluated in the reaction conditions. The goal is to improve the efficiency of the catalytic processes. In this context, neutrons have the potential to probe the structural aspects, the chemical mechanisms and the mobility of the active species.