Physical-chemical processes on cold surface

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The solid state physical-chemistry at low temperature is governed by the diffusion and interaction of reactants on the surface. In astrochemistry, hydrogen diffusion and hydrogenation reactions are commonly considered as the events most likely to occur on interstellar dust. Nevertheless, in literature the key role of oxygenation in the interstellar medium, leading to the formation of both interstellar ices and pre-biotic molecules, is often omitted. The focus of my thesis is the investigation of these overlooked oxidation processes.

The presented experiments have been performed with the FORMOLISM set-up, located in the Université de Cergy Pontoise, Observatoire de Paris. Via a triply differentially pumped beam, atoms and molecules are aimed at a cold (>6 K) sample held in the UHV chamber. The products are probed using Temperature Programmed Desorption and Reflexion Absorption Infrared Spectroscopy.

The results show that oxygen is very reactive with many species, and O diffusion appears to be much faster than previously expected. Moreover, some gas-solid coupling processes are extensively explored (adsorption, sticking, thermal desorption, chemical desorption, ortho-para ratio variation, among others) for various molecules. Experiments unfold unexpected results, especially with regard to the substrate composition (water ice, silicate or graphite) and morphology (crystalline or amorphous).