Water formation through O_2+D pathway on cold silicates and amorphous water surfaces of interstellar interest

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Interstellar water formation has been intensively investigated in the past decade. Many studies from different groups have shown an efficient formation through the hydrogenation/deuteration of O atoms, O_2 and O_3 ices [1-3], mostly in the multilayer regime [1,2]. We present the first experimental results for D_2O and D_2O_2 molecules formation through O_2 +D pathway in the sub-and monolayer regimes on bare amorphous silicate grain analogs. For comparison, we investigated water formation on porous and non-porous amorphous solid water ices surfaces held at 10 K [4]. The experiments were performed with the FORMOLISM setup using atomic deuterium and molecular oxygen triply differential pumping beam lines. We covered the surface of the sample with one monolayer of solid O_2 at 10 K and we irradiated the film with D-atoms at the same surface temperature until the destruction of the oxygen species. The gas surface reactions were analyzed with Reflection Absorption Infra-Red Spectroscopy (RAIRS) and Temperature-Programmed Desorption (TPD) techniques.

Results showed that the formation of D_2O water molecules is very efficient through the O_2+D pathway, but one fraction of the newly formed water stays on the dust grains at 10 K, and the other fraction is released into the gas phase. The fraction of water molecules desorbing into the gas phase upon formation depends strongly on the substrate (silicate or water ice). In the case of the silicates, about 90 % of the newly formed D_2O water molecules are released into the gas phase by chemical desorption process [5]. The non-thermal desorption of D_2O water products results from the high exothermicity of the $OD+D \rightarrow D_2O$ reaction [6]. These results are supported by a kinetic chemical model taking into account the high desorption rate of water products.

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