Non-planarity of icy grains surface in molecular clouds: impact on O_2 formation

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The growth and composition of the icy mantle of grains in molecular clouds is determined by their interaction with the gaz phase. The exchanges between the gaz phase and the solid phase do not only depend on the adoption and desorption rates but also by the geometry of the grains surface. Indeed, icy grains are highly porous and uneven and desorbed atoms and molecules have a significant probability to collide with the surface of the grain and be recaptured. Using a simple model we estimate the effect of recapture on atomic and molecular exchange between the solid and gas phases. We show that compared to a planar surface, on uneven or porous surfaces, hydrogen is more likely to out-diffuse from the grain than heavier species. We estimate the impact of this enhanced hydrogen escape on the composition of the grain's icy mantle. We focus in particular on the production of O_2 as unexpectedly large amounts of O_2, probably incorporated in the comet when it formed, have been detected in the coma of comet 67P by Rosetta. To reproduce such large amounts of O_2 in the solid phase, models of molecular clouds or protosolar nebula overproduce O_2 in the gas phase. Our results suggest that the higher escape probability of H on non-planar surfaces can contribute to enhance the production of O_2 in the grains icy mantle while keeping it low in the gas phase.