Stress-Induced Electric Currents in Icy Bodies

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The electrical properties of H_2O-ices have been intensely studied, albeit seemingly never under stress gradients. We report on electric currents generated at -81°C in pure and H_2O_2-doped H_2O-ices subjected to stress gradients. Baseline currents in pure H_2O ice were in the 10^{-10} A range. No stress-induced currents (SICs) were recorded in pure H_2O ices as exemplified in **Figure 1a**. By contrast, stressing H_2O_2–doped H_2O ices led to 1000 times stronger currents as exemplified in **Figure 1b**, indicative of positive charges flowing down the stress gradient.

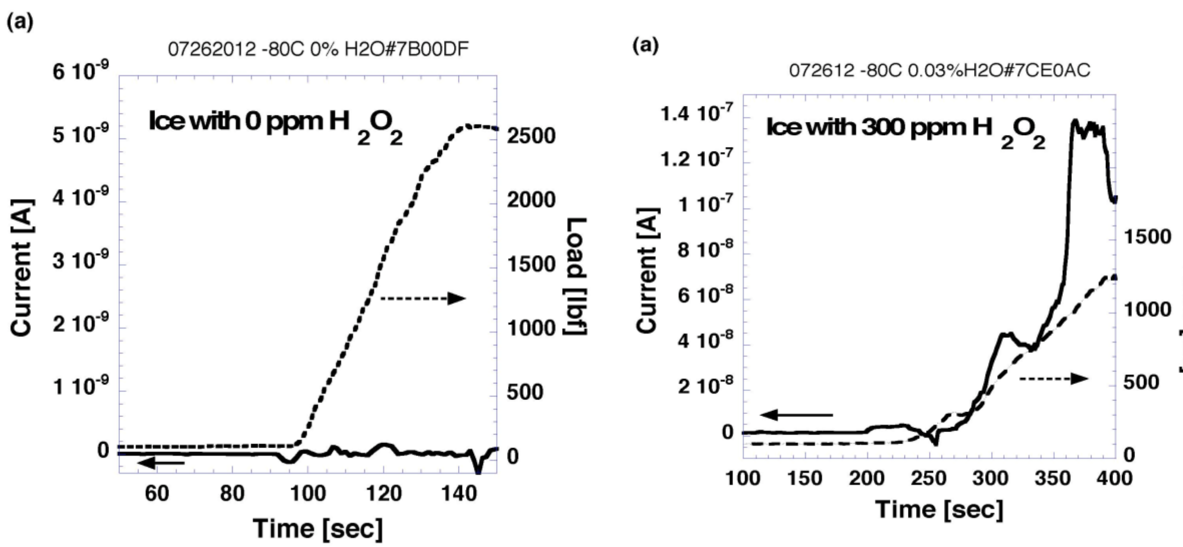

Figure 1a: *Current at -81°C in pure H_2O ice indicating low current, nearly unresponsive to applied stresses up to about 5 MPa.* ***Figure 1b:*** *Stress-induced current in H_2O_2-doped H_2O ice.*

H_2O ice is a molecular solid, in which the H_2O molecules are held together primarily by H-bonds. Pure H_2O ice exhibits weak protonic conductivity but lacks an electronic contribution. Adding a few ppm H_2O_2 should not affect its electric properties. This is true so long as the H_2O_2-doped H_2O ices are not stressed. Applying stresses causes positive hole-type charge carriers to appear, e.g. electronic states associated with defect electrons in the O^{2-} sublattice, equivalent to O^-. The mechanism probably involves an electron transfer into the O^--O^- bond of H_2O_2, the generation of an electron-hole pair with e' trapped in the broken peroxy bond, while $h^•$ becomes mobile and capable of spreading out of the stressed subvolume into the unstressed ice.

A hole in the O^{2-} sublattice represents a highly reactive, highly oxidizing •O radical. Thus, the flow of $h^•$ along stress gradients in dynamically active icy bodies such as Europa, one of Jupiter's moons. is expected to be accompanied by oxidation reactions along their path.