TECHNICOLOR EUROPA: EXPLAINING EUROPA'S SURFACE COLOR WITH IRRADIATED SALTS.

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Introduction: The heavily irradiated icy surface of Jupiter's moon Europa shows a distinct yellow-brown discoloration that may serve as a window into the chemistry of Europa's putative subsurface ocean. Here we show that sodium chloride, when exposed to temperature and irradiation conditions comparable to Europa's surface, accumulates electrons in F- and M-centers, resulting in a yellow-brown discoloration comparable to Europa's surface (Hand & Carlson, *submitted*). We conclude that if sodium chloride is a dominant salt within Europa's ocean then the discoloration of non-ice material associated with geologically active regions is likely a result of the irradiation of endogenous oceanic salts.

We conducted a set of experiments to measure changes in NaCl, KCl, $MgCl_2$, and mixtures therein, as a function of exposure to the temperature, pressure, and radiation conditions relevant to Europa. Reagent grade salts were placed onto a diffuse aluminum target at the end of a cryostat coldfinger and loaded into an ultra-high vacuum chamber. The samples were then cooled to 100 K and the chamber pumped down to $\sim 10^{-8}$ Torr, achieving conditions comparable to the surface of Europa. In all cases the samples were then irradiated with 10 keV electrons with an average current of 1 μA.

Several different experiments were conducted to examine a range of possible conditions for salts on the surface of Europa: pure salts grains (~300 μm diameter), salt grains with water ice deposited on top, and brine mixtures. In the case of brines, saturated salt water was loaded onto the cryostat target, the chamber closed, and then slowly pumped down to remove the water, leaving behind a salt evaporate for irradiation.

We observed a yellow-brown discoloration in NaCl caused by F- and M-centers formed in the irradiated salt. KCl was observed to turn a distinct violet. The electron bombardment results in the trapping of electrons in halogen vacancies, yielding the so-called color centers, or F- and M-centers [1, 2]. In NaCl these centers have strong absorptions at 450 nm and 720 nm, respectively, providing a highly diagnostic signature of otherwise transparent alkali halides [3, 4, 5], making it possible to remotely characterize and quantify the composition and salinity of Europa's ocean.

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