Perchlorate Formation by Electrochemistry in Martian Dust Events –II

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We have reported early[1,2,3] that the electrochemistry processes, through Mars atmosphere to surface interaction induced by Mars Dust Storm and Dusts Devil, can be an important mechanism to form oxychlorine salts (Cl^{+1}, Cl^{+3}, Cl^{+5}, Cl^{+7}), which would be extremely important for Cl-cycle on Mars. This abstract reports further in-depth electrostatic discharge (ESD) experimental studies on Cl-phase transformations, started from three chloride salts (Na, Mg, Ca), with or without structural H2O, with an emphasis on the yields of (per)chlorates, their depth-dependence, and the potential intermediate Cl-O-species during Mars dust events.

We built an apparatus in our Planetary Environment and Analysis Chamber (PEACh)[1,4], and realized stable ElectroStatic Discharge (ESD) in the form of Normal Glow Discharge (NGD). The PEACh is capable of maintaining Mars atmospheric pressure, composition (pure CO_2, CO_2+H_2O, and Mars Simulating Gas Mixture), and a well-controlled sample temperature range relevant to Mars surface and shallow subsurface, and with four *in situ* sensors for the characterization of molecular species as solid, liquid, and of atomic & ionic species in ESD-stimulated plasma.

We found (1) with the same electron flux density and the same ESD time duration, the perchlorate yields from a set of different ESD sample cells are proportional to the effective electrode area ratio (100:31:3.4), which suggests that the electron avalanches generated by ESD-NGD have extremely large number of electrons to react with the chloride molecules with high productivity; (2). The types of cation in starting chloride salts does have an effect on the yield of (per)chlorates, $MgCl_2$ transfers to $Mg(ClO_3)_2$ and $Mg(ClO_4)_2$ more readily than the similar transformation from NaCl and $CaCl_2$ to relevant (per)chlorates; (3) an obvious surface enrichment of ClO_3 in all experiments indicating an atmosphere-surface interaction; (4) the existence of structural H_2O in the starting species influenced the yield of (per)chlorates; (5) the yield of ClO_4^- is much lower than that of ClO_3^- when started from chlorides, but much higher when the starting phase is $NaClO_3$, implying a sequential generation of ClO_4^- is possible on Mars. The next step of our study is ongoing in two aspects: (a) catalysis effect of co-existing species and (b) Cl-isotopic differentiation.

[1] Wu & Wang, 2016, LPSC, #2227; [2] Yan et al., 2017, LPSC, 2413; [3] Wang et al., 2017, LPSC, #2685;
[4] Sobron & Wang, 2011, J. Raman Spectroscopy, DOI 10.1002/jrs.3017.

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