THE ROLE OF RADIATION IN NEAR SURFACE HABITABILITY OF EUROPA. Murthy S. Gudipati[1] and Bryana L. Henderson[2]; [1]Ice Spectroscopy Lab, Science Division, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, USA; gudipati@jpl.nasa.gov; [2]Caltech Postdoctoral Fellow at JPL; bryana.l.henderson@jpl.nasa.gov

Introduction: Radiation - a general term used for any energetic particle or photon - is an integral part of space and contributes to the dynamics of the evolution of matter in the Universe and life (as we know it) on Earth. While radiation can provide energy to help sustain life, radiation is generally considered lethal to life and hence poses constraints on habitability of various objects in our solar system and other similar solar systems in galaxies.

Europa: Among potentially habitable bodies in our solar system, Europa [Pappalardo, McKinnon et al. 2009] stands alone due to its tidal flexing generating energy from within, having a vast amount of ice, and potentially large reservoirs of water. However, Europa's surface is highly susceptible to Jupiter's magnetospheric radiation caused by internal dynamo effect and consisting of very high energy electrons and ions. Due to lack of an atmosphere that could attenuate a majority of the solar and Jovian radiation, Europa's surface is completely exposed to radiation - making an extremely harsh environment for life to survive even for a short period of time. On the other hand, the surface ice could act as a shield for harsh radiation and allow only useful radiation and/or energy rich oxidants to reach the subsurface of Europa. Studies indicate certain chaotic terrains may be indicative of shallow liquid activities [Schmidt, Blankenship et al. 2011]. With this connection, it is critical to understand how deep can life flourish and survive under Europa's surface and at what depths Europa becomes habitable. This contrasting dichotomy that the subsurface is potentially habitable but not the surface makes Europa a very fascinating body to study and understand. Thanks to past, present, and future missions to Europa, we will be in a position to more closely constrain habitability on Europa and evaluate whether life exists or could exist on Europa.

Laboratory Studies Simulating Europa's Surface: We have been examining electron and photon induced damage to organics in ices at Europa's surface conditions in order to understand the effect of radiation on life/organics on Europa [Barnett, Lignell et al. 2012]. We have been using polycyclic aromatic hydrocarbons (PAHs) as surrogates for biomolecules in addition to volatile organics such as methanol, methane, carbon dioxide, and the nitrogen-containing molecule ammonia.

Results: Several years ago we showed that organic molecules are efficiently ionized in ice environments [Gudipati and Allamandola 2003], making charge-mediated chemistry a new pathway for chemical reactions in ice, in addition to neutral radicals mediated chemistry involving bond-dissociation. We have also demonstrated that even under very low temperatures, organics are oxygenated leading to the formation of hydroxyl functional group, and unsaturated molecules such as PAHs are additionally hydrogenated [Gudipati and Yang 2012; Henderson and Gudipati 2015]. As a consequence, the surface of Europa must have all these reactions occurring should there be organics present within the reach of the radiation.

Recently we expanded our studies on in-situ analysis of radiation-processed ice composition using a two-step laser ablation and laser ionization mass spectrometry (2C-LAIMS). Results from these studies will be presented and discussed in detail.

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