Concept testing of a low power pyroelectric X-ray source for application in planetary explorations

Hannah Munguia-Flores, Bryan Y. Zhong, Kyle Uckert, Robert P. Hodyss and Christopher M. Heirwegh*

Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena CA 91109.

* christopher.m.heirwegh@jpl.nasa.gov

The National Aeronautics and Space Administration has long relied upon X-ray fluorescence instrumentation to provide robust geochemical analysis of other worlds. Implementation of X-ray instruments aboard spacecraft demands conservative use of operational resources. As smaller, cost effective spacecraft continue to be called upon, these resource and operational restrictions may prohibit the selection of conventional elemental mapping instruments. These limitations drive ongoing efforts to develop instruments that consume minimal levels of power, have simplicity of design, are robust in diverse environments, and are capable of producing spectroscopic analysis of comparable quality to earlier generation instruments.

The Pyroelectric Instrument for Rock Analysis (PIRANA) is a test bed X-ray spectroscopy instrument being examined for potential use on board spacecraft. Its basic design incorporates two opposite facing $LiTaO_3$ pyroelectric crystals mounted on a copper bracket with thermal electric coupler assembly. As a technology proposed for use on spacecraft, efforts are underway to assess feasibility through maximizing primary X-ray flux and energy of emitted radiation. This presentation will showcase some of the early results of this endeavor. Variables tested include effects of crystal separation, air-gas chamber pressure, and crystal composition. Through chamber-cycling experiments, we learned that short crystal separations and a vacuum pressure of 16 mTorr were ideal for increasing flux. We also characterized the primary emission spectrum to identify spectrum Gaussian and non-Gaussian features.

Ongoing and future efforts include development of testbed operational software, development of the existing PIQUANT code to calculate the pyroelectric primary spectrum, and further testing of variables, including: crystal thickness, geometry, crystal materials, crystal surface preparation, gas type, and pressure.