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THERMAL EXPANSION INFLUENCE ON THE SPACE MASS SPECTROMETER BASED ON CERAMIC KINGDON TRAP

Abstract

One of the most desired next steps of space exploration is a Moon surface mission. Moon soil analysis by mass spectrometry can give us a lot of information that will help in future Moon exploration. Polar Moon regions have not been properly investigated yet. For further research in this area, we need to develop instruments with proper characteristics that will have the opportunity to maximize the precision of measurements of mass of soil components while minimizing the power consumption.

Kingdon ion trap based mass spectrometers can provide the high resolution needed for the Moon. Their manufacturing is a challenging problem, as high precision is required. The precision is required starting with the accuracy of the initial model, going through control during all steps of the manufacturing and assembly process and ends with a robust, high precision sensor that can survive the launch and landing environments of a Moon mission. Our prospective mission is to the Moon's Polar regions.

Metalized ceramic has good thermal characteristics that can provide high robustness of the system during a big temperature range. On the other hand, ceramic as a material could be more fragile than metal and could be destroyed under stress. Thermal compression could decrease the precision of the assembly or even change the geometry of the ion trap that will affect the results of the measurements. We are proposing to introduce corrections to the shape of the surface that electrodes have at room temperature in such a way that after thermal compression at 97K (average temperature of the Moon Polar Caps area), the surface has a shape corresponding to ideal performances of the instrument.

The goal of the research is to conduct a thermomechanical analysis of the 3D printed ceramic Kingdon ion trap, for the conditions of the Moon surface. At this point, we have created the prototype, performed thermal expansion analysis and tests. This paper will discuss the methods of producing this high precision instrument and results of initial analyses and test on its' performance in the Moon's environment.