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Converter Electrode Erosion Processes in the H^- Ion Source at LANSCE

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During the 2014/2015 LANSCE beam production period an unexpected degradation of the converter surface in the H^- ion source was observed. Small dimples were created in the center of the molybdenum electrode on the smooth, curved electrode surface during normal beam production cycles (see Figure 1).

In ordered to understand the observed degradation of the ion source, a simple model of the electrode surface degradation was developed. In the model were included several dominant atomic collision processes in H^- ion source and high voltage electrostatic extraction column (U= 80 kV). The model includes the following collision processes: the electron impact ionization on molecular hydrogen [1], the electron impact ionization on atomic cesium [2], ion-beam sputtering of hydrogen ions (H^+ and H_2^+) on a molybdenum surface [3], ion-beam sputtering of cesium atoms (Cs^+) on a molybdenum surface [3], and arc discharge plasma sputtering.

Model results indicate that the observed dimples seen on the converter electrode surface was caused by an increase of extracted electron current and unbalanced cesium oven temperature. The model explains that hydrogen ions have no significant influence on the converter electrode dimpling. The dominant electrode mass loss mechanism is found to be the beam sputtering caused by high energy single charged positive Cs ions.

Based on the measured sputtered Mo mass during regular beam operation of the ion source, the partial Cs vapor pressure was estimated, showing elevated Cs injection inside the source and the high-voltage extraction column.

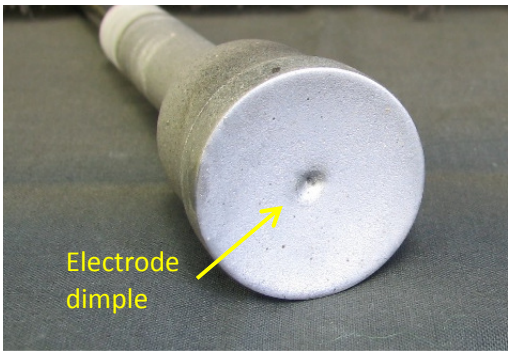

Figure 1. A dimple of 2 mm deep and 5 mm wide created in the center of the molybdenum converter electrode is shown.

References

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2) M. Lukomski, et al., "Electron-Impact Ionization Cross Sections out of the Ground State 6 ^{2}P Excited States of Cesium", Phys. Rev. A, **74**, 032708 (2006).

3) Y. Yamamura and H. Tawara, "Energy Dependence of Ion –Induced Sputtering Yields from Monoatomic Solids at Normal Incidence" *Atomic Data and Nuclear Data Tables,* **62**, p 149-253, (1996).