Influence of the cathode material on the neutron production rate of Inertial Electrostatic Confinement Fusion device

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The present work focuses on studying the influence of the electrode material on the neutron yield from the inertial electrostatic confinement fusion (IECF) device. Two cathodes, with 4 cm diameters fabricated from stainless steel and titanium in the buckyball shape, were used to perform the study. Experimental setup, conditions, and overview of the results will be presented and discussed in the meeting.

Keywords: IEC, Cathode materials, DD Fusion, Titanium.

1. Introduction

Inertial electrostatic confinement fusion (IECF) is a method for trapping light atoms, such as D, T, H, He, to start fusion by use of electric filed. IEC, in its straightforward configuration, is consisting of a concentric spherical transparent cathode at a negative bias in the center of a vacuum chamber, which serves as an anode at ground potential (Fig. 1). Fusion in IECF device is taking place via various kinds of collisions: (i) ions vs. ions, is preferable but it is negligibly small, (ii) ions vs. gas target, predominant in a wide range of operational conditions, (iii) ions vs. cathode grid, and (iv) charge exchange with electrodes. This study focuses on fusion generated from ions vs. cathode. Two cathodes, 4 cm diameters made from stainless steel (SS) and titanium (Ti), were used to perform the study. The anode was made from SS, and D gas has been used as a fule for the operation. The DD neutron production rate (NPR) from the cathodes was scanned as a function of applied voltage and current (Fig. 2).

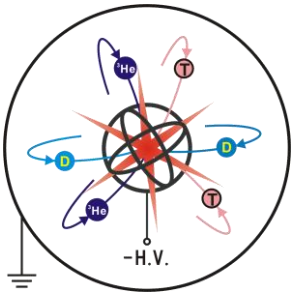

Fig.1 IEC configuration and the fusion paths.

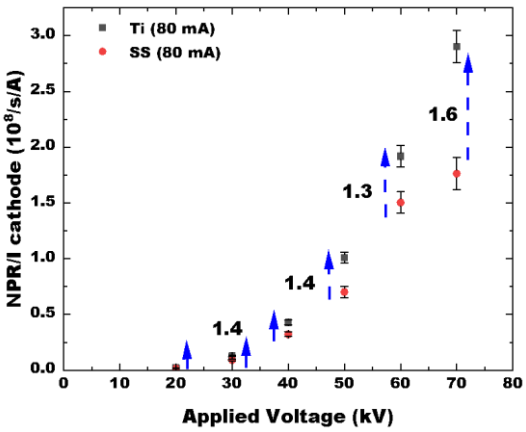

Fig. 2. NPR/I-cathode from the Ti and SS cathodes as a function of the applied voltage.

2. Results

The measured NPR/I-cathode from Ti and SS cathodes as a function of the applied voltage revealed that, under the same conditions, the NPR from Ti cathode is ~1.5 higher than SS one. The effect of the cathode material can explain this behavior. It is reported that adsorbed/embedded hydrogen ions on the Ti surface are ~ three times higher than the SS one [1,2]. Therefore, a fusion takes place between the energetic ions, and the adsorbed /embedded ions on the Ti cathode surface are much higher than the SS one.

3. Conclusion

The NPR/I-cathode from Ti cathode is ~1.5 times higher than the SS one, which can be referred to as the affinity of Ti material to adsorb hydrogen ions if much high compared to the SS one.

[1] K. Christmann, O. Schober, G. Ertl, and M. Neumann, J. Chem. Phys. 60(11), 4528–4540 (1974).

[2] P. W. Tamm and L. D. Schmidt, J. Chem. Phys. 55(9), 4253–4259 (1971).