Influence of the Cathode Material Properties in Reducing the Back-Bombardment Effect in Thermionic RF Gun

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Abstract:

The effect of back-bombardment (BB) electrons is considered one of the main obstacles for extensive use of thermionic RF guns (T-RF). The 10 hexaboride materials named (Ca, Sr, Ba, La, Ce, Pr, Nd, Sm, Eu, and Gd) B6 are investigated in this paper to survey the effect of the cathode material on reducing BB electrons and compare them with LaB6 (which is widely used as a thermionic cathode). A numerical model was used to conduct this paper. Besides the numerical calculations, an experiment has been performed to determine the work functions of CeB6 and LaB6. The results from the numerical calculations revealed that (Ba, Ca, and Nd) B6 are less affected by BB electrons: 42%, 50%, and 59%, respectively, compared with LaB6, for low beam current applications. In contrast, for high beam current duties, (Nd, Ce, and Sm) B6 have minimum influence by BB electrons compared with other hexaborides. The study concluded that BB electrons are strongly affected by the properties of the cathode material, especially thermionic emission and material density. Moreover, the study suggests that it is worthwhile to prepare BaB6, CaB6, NdB6, and SmB6 as cathode materials, then to subject them to a real experimental test using T-RF gun to compare their performance and BB effect against LaB6.

Keywords:

Backbombardment (BB), electron acceleration, hexaborides, radio frequency (RF) guns, thermionic emission, work function

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