Design of a thermal field electron gun immersed in the magnetic lens field

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Scanning electron microscopes (SEM) are confronted with low speed[1, 2]. The thermal field electron gun immersed in a magnetic lens field can achieve high throughput and rapid imaging by enhancing the probe beam current of the SEM[3].
In this work, a magnetic field immersed thermal field electron gun was designed, which enables efficient collection of electrons emitted from the cathode, thereby increasing the effective emitted beam current. The optical characteristics of the magnetic field-immersed thermal field electron gun were analyzed theoretically. The performance of three different magnetic lens designs which are the single polepiece, the double polepiece with axial gap and the double polepiece with radial gap was simulated and compared. Based on the double-polepiece axial-gap lens, a magnetic field-immersed electron gun was developed, and the variations in beam spot size, beam current, and angular current density with respect to the magnetic immersion lens were systematically analyzed. The magnetic field distribution of the immersion lens and the effective emitted beam current of the gun were measured based on an experimental platform. The effective emitted beam current of the proposed magnetic field-immersed thermal field electron gun reached 44.97 nA at a low acceleration voltage of 3.3 kV and 638.12 nA at a high acceleration voltage of 23.5 kV, representing an approximately fourfold increase compared to that of a conventional thermal field electron gun (see Fig. 1).

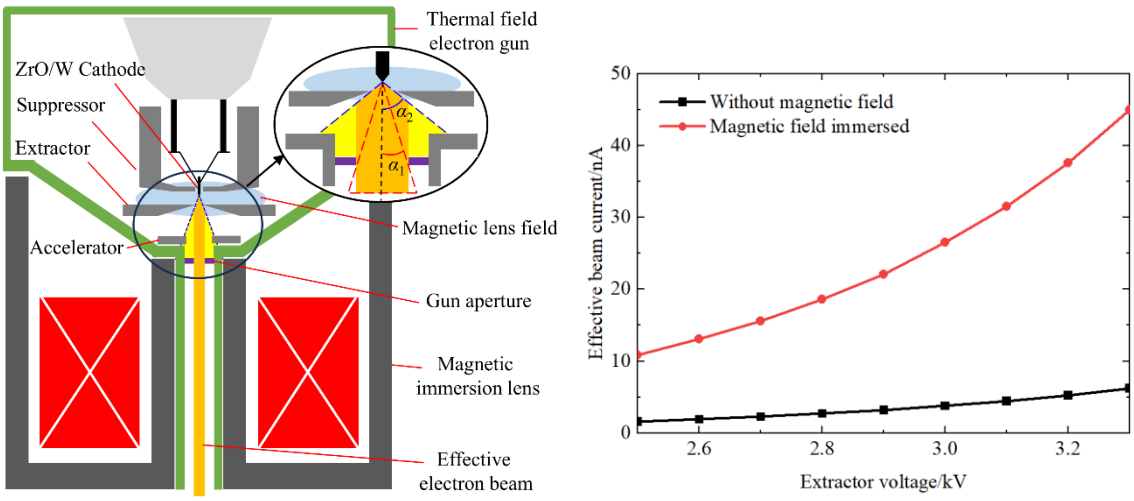

Fig 1 Left: Schematic design of the magnetic field immersed thermal field electron gun. Right: Experimental results of the effective beam current variation with the extractor voltage.

References:

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