四极管等效二极管空间电荷限制流研究进展*

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摘 要:可持续绿色能源核聚变具有清洁环保、原料储量丰富、安全可靠、不产生核废料等优点,是解决未来能源及环境问题的重要选择。然而,实现受控核聚变并非易事,托卡马克是最有希望实现可控聚变能的磁约束装置。大功率真空发射管是托卡马克装置中的一个重要器件,其电流作为发射电子管极限参量和额定功率的一个重要指标,取决于发射管本身的结构、尺寸、材料等。由于四极管的结构和工作原理十分复杂,很难直接获得发射电流随其结构参数变化的情况。可先将四极管等效成二极管结构来探寻二极管空间电荷限制流随其几何结构变化的规律,从而为等离子体加热发射管(四极管)结构设计及优化提供理论参考和有效依据。对此,本文通过查阅相关文献和书籍,对二极管空间电荷限制流方面国内外的研究状况进行总结和分析,并展望了其发展趋势。

关 键 词:核聚变;发射管;真空二极管;空间电荷限制流;热电子发射

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Research Advances on Space Charge Limiting Current of Equivalent Diode for Tetrode

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Abstract: Due to the advantages of clean and environmentally friendly, abundant raw material reserves, safety and reliability, and no nuclear waste, sustainable green energy nuclear fusion has become an important choice to solve energy and environmental problems in future. However, achieving controlled nuclear fusion is not easy. Tokamak is the most promising magnetic confinement device to realize controllable fusion energy. High power vacuum launch tube is an important component in the Tokamak device. As an important index of the limit parameter and rated power of the transmitting tube, its current depends on the structure, size, material of the transmitting tube itself. The structure and working principle of the tetrode are very complex, so it is very difficult to obtain the variation of emission current with its structural parameters. Therefore, the tetrode can be equivalent to diode structure to explore the law of space charge limited current of diode changing with its geometric structure. The results can provide reference and theoretical basis for the structure design and optimization of the plasma heating transmitting tube. At present, there are many analyzing methods and special simulation software, and they have been widely used in the space charge limiting current. In this regard, by reviewing the related literature and books, the research status of the space charge limited current of the diode at domestic and overseas are summarized and analyzed, and the development tendency is prospected.

Key words: nuclear fusion; transmitting tube; vacuum diode; space charge limited current; thermionic emission

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