石英板夹层中窄电极结构与材料对直流放电的影响 *

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摘 要:研究了一种石英板夹层窄电极放电装置的低气压直流放电过程,重点探讨了电极结构与电极材料对等离子体参数的影响,其中电极要求宽高为 4mm,间距大于 40mm。实验采用朗缪尔双探针法诊断,通过改变气压、放电功率等条件分析了电极结构对自制的直流等离子体放电装置的电子密度分布及电子温度的影响。结果表明:通过增加电极表面积,采取特殊的电极结构都可以有效地提高等离子体密度。实验中还发现,随着气压降低,正柱区逐渐缩小、等离子体密度沿电场方向变化趋于平缓,阳极的直流等离子体密度逐渐升高,这时等离子体空间分布均匀度提高,且在 16Pa 时取得最大值。

关 键 词:等离子体;直流放电;放电电极;均匀度;电子密度

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Effect of Structure and Material of Narrow-Electrode with Quartz Plate Interlayer on DC Plasma Discharge

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Abstract: In this paper, the low-pressure DC discharge process of a narrow-electrode discharge device with quartz plate interlayer was studied. The influence of electrode structure and material on plasma parameters was discussed. The electrode width is 4 mm and the spacing is more than 40 mm. The experiments were carried out by using the double probe needle method. The influence of electrode structure on the electron density distribution and electron temperature of the home-made DC plasma discharge device was analyzed by changing the pressure and discharge power. The results show that the plasma density can be effectively increased by increasing the surface area of the electrode and adopting special electrode structure. It was also found that with the decrease of air pressure, the positive cylinder area decreases gradually, the plasma density changes gently along the direction of electric field, and the DC plasma density of the anode increases gradually. At this time, the uniformity of plasma spatial distribution increases, and the maximum value is obtained at 16Pa.

Key words: plasma; DC discharge; discharge electrode; uniformity; electron density

低温等离子体在半导体工业、材料制备、真空镀膜、微电子等领域中已得到广泛应用[1-4]。在这些应用中,一般用粒子密度、粒子温度、成分构成等来描述等离子体性质。而这些参数的变化取决于阴极材料、阴极结构、放电模式、电源频率[5]、放电功率、气压、放电气体等实验条件的不同。

石英板夹层放电指的是在石英板间利用交流放电、直流放电、射频放电等方式产生等离子体。由于其放电空间狭窄,已被应用于多个领域,如霓虹灯照明等。同时由于其优秀的等离子体覆盖能力,还可以被应用在航天飞机的表面隐身[1,3]。这些应用都与石英板夹层放电的放电参数相关。大多研究者致力于改变等离子体放电参数与阴极材料以提高等离子体密度[1,3],但同时也有一

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