SUPPRESSION OF MOVING STRIATIONS IN THE DIRECT CURRENT GLOW DISCHARGE

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The use of tapered discharge tube with a small taper angle instead of cylindrical one makes it possible to create the longitudinally nonhomogeneous plasma, in which the conditions for the excitation of striations vary along the tube axis. As this takes place the discharge becomes stable for the appearance of moving striations not only near the lower critical currents [1,2], but also near the upper ones. The plasma stabilizing action of the taper derives from the fact that in the tapered tube the amplification of striations takes place only in a certain part of the tube (striation space increment $\varkappa > 0$), but in other parts of the tube striations are damped ($\varkappa < 0$). As the taper angle increases, with the constant tube length, the region of the striations amplification decreases and the region of the striations damping increases. This fact makes difficult the creation of moving striations in the plasma.

The investigations were carried out in the positive column of the direct current glow discharge in the spectroscopically pure neon gas. The tapered discharge tubes with taper angles $\alpha \sim 3°$ (tube 1) and $\alpha \sim 8°$ (tube 2) were used. The radii of the small and large taper ends were equal to r_1 = 1 cm, r_2 = 3 cm (tube 1) and r_1 = 0,75 cm, r_2 = 4,2 cm (tube 2). The tube electrodes were the hollow nickel cylinders with working areas much larger than the areas of the appropriate tube parts. Any one of electrodes could serve as a cathode as well as an anode. Both electrodes could move along the tube axis in the tube 2, but only the small diameter electrode was movable in the tube 1. The detailed description of the experimental device cited in the article [2].

The existance range of moving striations (in current-pressure coordinates) for the tapered discharge tubes is much smaller then

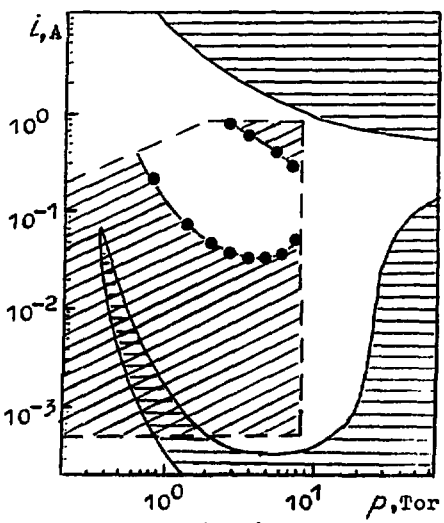

Fig. 1

such range for the cylindrical tubes of any tube radii $r_1 \leq r \leq r_2$. The curves with points of Fig. 1 show the boundaries of the existance range of self-excited moving striations in the tube 2 for the case when the anode is placed in the narrow end of the tube. The dotted line denotes the investigated current-pressure region. The oblique shading indicates the range where the striations in the tapered tube are not detected. The horizontal shading denotes the striation-free range for the cylindrical discharge tube [3] which radius is equal to the mean radius of the tapered tube (r = 2,6 cm). It must be noted that striation-free range in the same tapered tube becomes larger when the anode is placed in the wide end of the tube. In this case, at $0{,}5 < i$, mA < 170 and $0{,}2 < p$, Tor $< 1{,}5$, the self-excited striations are not detected at all.

The displacement of the cathode for a distance of $z \sim 15$ cm has no effect on the critical current for the striation origin. In contrast, even a slight displacement of the anode, up to 1-2 cm, considerably affects the value of the existance range of striations (in current-pressure coordinates) and is accompanied by the striation frequency change. Irrespective of whether the movable anode is located at the wide or narrow end of the taper, the existance range of striations decreases and their frequency also decreases when the anode moves to the larger radius r [2]. The change of the critical currents in this case is apparently connected with the feedback efficiency decrease because of the decrease of space increment and striation amplitude as the radius r near anode increases [2].

The parameters of the external circuit have a great influence on the critical currents of the self-excited striations in tapered discharge tubes. This fact is illustrated by the set of curves in the Fig. 2, which presents the dependence $i_{cr}(p)$ with external inductance as a parameter (numbers near curves indicate values of inductance). Presented data show that the increase of the external inductance cases the significant reducing of the existance range of moving striations (in current-pressure coordinates). So it is clear that in the wide range of pressures and currents the feedback for the striations in the tapered discharge tubes is realised by the external circuit and not by the plasma backward wave.

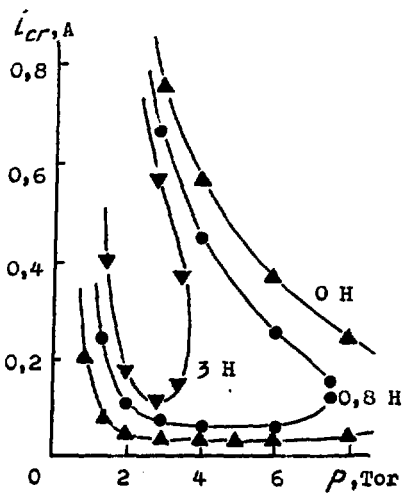

Fig. 2

The mentioned above extremely great influence of the external circuit parameters on the existance range of striations is connected with the fact that in the tapered discharge tubes the striations are considerably weaker than in cylindrical tubes by the same conditions. For example, in the tapered tube 2 with the anode in the narrow end at pressure p = 6 Tor the light modulation caused by the moving striations do not exceeds 20 %.

As a discharge tube was used also a combined tube the central part of which was the cylinder with radius r = 3 cm and length ℓ = 70 cm. The tapered tubes with the taper angle $\alpha \sim 8°$ and length ℓ = 30 cm were soldered to the both ends of the cylinder part. The appreciable reducing of the existance range of striations in such tube as compared with the cylindrical discharge tube takes place irrespective of the electrodes polarity. The curve with points on the Fig. 3 denotes the boundary of the existance range of self-excited moving striations in the combined tube. The investigated region of currents and pressures is indicated by the dotted line. The striation-free range of currents and pressures in the combined tube is denoted by oblique shading and in the cylindrical tube with the radius r = 3 cm [3]- by horizontal shading. It was revealed that the striation characteristics in the combined tube are determined by its cylindrical part. The space amplification of the striations takes place along the cylindrical part. The striations are appreciably damped in the conical parts that at the essential role of the feedback leads to the reduction of the existance range of striations (in current-pressure coordinates).

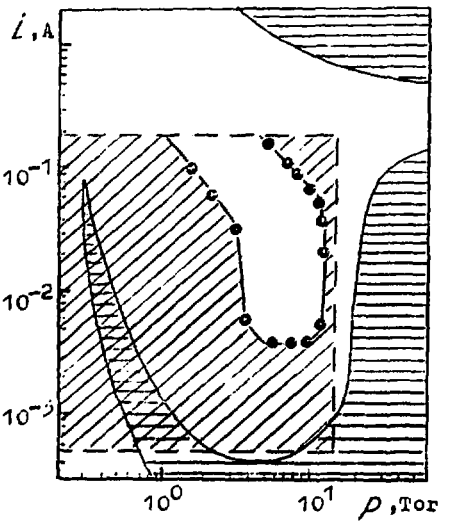

Fig. 3

References

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