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DOUBLE SURFACE WAVE DISCHARGE – A NEW KIND OF WAVE SUSTAINED DISCHARGES

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Discharges in which plasma is generated by the surface wave, and at the same time serves as a medium that allows wave propagation, were designed in 1970's. They are so called surface-wave-sustained discharges (SWDs) [1]. Two main types of SWDs geometries are known: cylindrical, which was historically first [2], and planar reported a decade later [3]. Four main types of cylindrical configurations of SWDs are presented in Fig. 1.

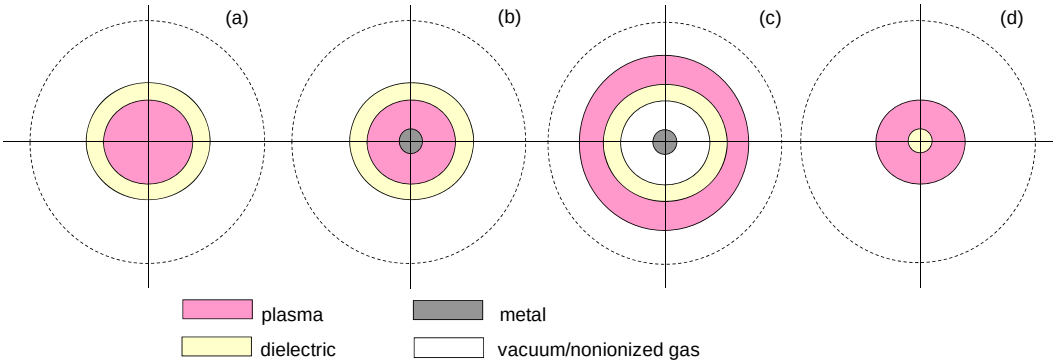

Fig. 1. Four cylindrical configurations containing plasma, in which SWDs can be generated. The dashed line represents an optional part introduced by a metal tube.

The configuration presented in Fig. 1a is so-called a conventional SWD [1]. Plasma sustained by a surface wave has the shape of an elongated column surrounded by a dielectric discharge-tube or sometimes by metal walls. Fig. 1b shows a modification of the conventional configuration presented by Zhang *et al*. in 1989 [4]. Fig. 1c presents a configuration reported by Räuchle [5], where plasma hollow cylinder is generated outside a dielectric tube. Another configuration, disclosed in [6], is presented in Fig 1d. A cylindrical PTFE rod is placed in the axis and forms a waveguide, along which a surface wave propagates generating plasma. A few other cylindrical configurations have been also analysed but they may be treated as modifications of variations schemed in Fig. 1.

The configurations presented above do not constitute a complete set of all possible cylindrical configurations containing plasma that enable guiding a surface wave. A surface wave can propagate also in other configurations – mathematically it means that there is a solution of the wave equations that corresponds to a surface wave.

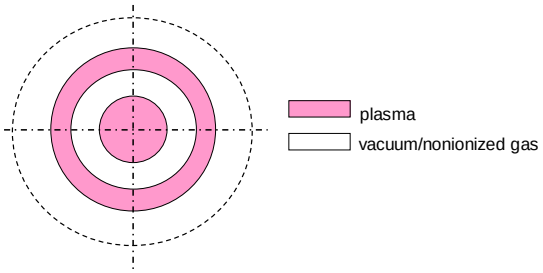

Fig. 2. New coaxial-plasma configuration – double surface wave discharge which is able to guide a surface wave.

It is proved in our contribution that there is a possibility of guiding a wave in a configuration, where not one but more separate plasma regions occur. A special case of such a configuration – with two plasma regions located coaxially – is presented in Fig. 2. The inner plasma region has the shape of a column, while the outer one has the shape of a hollow cylinder. The two plasmas are separated by the region of non-ionized gas (or vacuum). It can be practically obtained by coaxial-arrangement of three dielectric tubes and introducing working gases to the inner and the outer tubes, keeping vacuum or gas at higher pressure in the middle tube. Because a wave can propagate in such a plasma coaxial line, it is justified to assume that it is also possible to obtain a discharge sustained by this kind of wave. We refer this to configuration as a double surface wave discharge (2SWD). It is the purpose of this contribution to analyse theoretically and experimentally basic properties of this new kind of surface-wave sustained discharge. Numerical calculations of the wave attenuation and phase characteristics as well as electric field distributions have been performed. Presented are measurements of attenuation coefficient and dependencies of electron density on axial position from optical emission spectroscopy. Experimentally obtained data are in good qualitative agreement with theory and confirm obtaining 2SWD.

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