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CORONA AND HIGH FREQUENCY DISCHARGES*

VRATISLAV KAPIČKA**, Brno

High frequency plasma studies enable us to apply the physical effects existing within the plasma to technological processes.

Unipolar high frequency discharges and inductively coupled discharges serve as sources of spectrum excitation. The unipolar ones are used for ozone production, conversion of $SiCl_4$ into $SiHCl_3$ and for glass preparation.

Hf discharge plasma is utilized to prepare organic samples for spectral analysis. It may produce thin polymorphous films. Plasma treatment also serves for etching and cleaning of polymer surface films. Hf discharges burning in inert gases are sources of continuous radiation.

ПРИМЕНЕНИЯ КОРОННОГО И ВЫСОКОЧАСТОТНОГО РАЗРЯДОВ

Изучение высокочастотной плазмы позволяет находить применения знаниям о физических явлениях, происходящих в плазме. Одноэлектродные разряды и индуктивно связанные разряды служат в качестве источников спектров. С помощью одноэлектродных разрядов можно образовать также новые химические соединения (конверсия $SiCl_4$ b $SiHCl_3$) и озон или же проводить обработку стёкол. Высокочастотные разряды используются для приготовления органических веществ, для спектрального анализа, для создания полимерных плёнок, а также для изменения свойств полимеров и снятия плёнок. Высокочастотные разряды в инертных газах служат в качестве источников излучения со сплошным спектром.

I. INTRODUCTION

The interest in low temperature plasma research has recently increased even though it does not solve such important problems as the high temperature plasma (thermo-nuclear reactions). The high frequency discharge plasma investigation is very effective not only in that it develops new methods for understanding the processes occurring in the plasma itself, but also for a number of their applications. It is known that the unipolar and inductively coupled high frequency discharges and those burning under reduced preseure as well have been found to be aplicable for

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** Department of Physical Electronics UJEP, Kotlářská 2, CS-611 37 BRNO.

technical use. The unipolar high frequency discharges burning at normal pressure are utilized in glass welding, spectra generation or ozone production, conversion of tetrachlorsilane into trichlorsilane, namely to plasmochemical reactions. High frequency discharges inductively coupled serve for the generation of spectra and the working of materials (e. g. glass), and those burning at low pressure are used in plasmochemistry and/or continuous spectra radiation.

II. METHOD, RESULTS

Reviewing the experimental data obtained on the above mentioned discharges the following applications may be proposed.

Corona discharge

It is an undesirable effect in electric energy transport. On studying the corona discharge burning on a sharp point against a plane desk, it has been observed [1] that the superimposed dc field may induce corona discharge decay and affect the acoustical and optical effects of the low frequency corona; in the case of a unipolar high frequency discharge the dc electric field may lead to plasmoides. A slight total current decrease of the coronizing point by the dc electric field is observed under entirely special conditions and within the measured errors only. The measurements have also shown a small change in the shape of corona, however, neither the discharge nor the current decay. At present the results considered do not favour an eventual application of the above effect to the energy transport by means of a trunk high voltage line. In the corona investigations, the influence of residual space discharges in the neighbourhood of the coronizing point on the ingniting and the forming of the corona has been proved.

Unipolar discharges

They can burn on both conducting and non-conducting materials, in various media, under different conditions more or less close to thermal equilibrium. Therefore, in the discharges there are generated spectral lines, which in commercially used spectral sources need not be generated. The sensitivity of the spectral analysis of solutions is greater in a number of cases than it is in the usual sources (the smallest provable amount is in many cases even smaller if compared to the sources used like K, Zn [2—5]). Gas spectra in discharges are generated very well. We are able to perform the spectral analysis of materials directly without any preceding modification [6]. In the discharge created plasma atomization of molecules and other processes take place making the plasma-chemical reactions

posible. Thus, the discharges are of use in the ozone production as ozonizers. Similarly, new chamical compounds are created, e. g. [7] conversion of $SiCl_4$ into $SiHCl_3$; also various films can be grown on the surfaces of some materials put into the discharge plasma owing to various elements of the electrode. Tests with the application of unipolar discharges have been performed especially in preparing some products — e. g. cement.

The electrode on which the discharge burns may be adapted to a burner through which plasma blown out may be used in industry for glass welding [8], and is suitable for spectral analysis as well. Some possible applications are refferred to in literature in connection with the engineering industry, where the above plasma is employed for treating and cutting materials. High frequency discharges burning at normal pressure. Inductively coupled discharge; in this case the discharge plasma temperature and the charged particles density are several times greater than those of the unipolar high frequency discharge. Discharges with a power output of about 10 kV (coil diamater approx. 0.06 m) are used for glass preparation; those having a reduced power output of approx. 1—5 kV (coil diamater about 0.03 m) serve as spectral sources for analyzing solutions (commercially produced by foreing firms, identified as ICP sources), where the analyzed solution is injected into the plasma. However, the treatment, the injecting and the sputtering of solutions are rather complicated.

Capacitively coupled discharge [9, 13]: the discharge consists of several parts. This discharge spectrum does not contain any lines of elements of the electrode. A further improvement concerning this discharge may be valuable for application in spectroscopy.

High frequency discharges burning at reduced pressure

Discharges burning in inert gases are sources of continuous spectra of bremsstrahlung. Because of this property it has been possiible to use them as normals of radiation (within the region between about 200 mμ and 60 mμ).

The above discharges plasma treatment (e. g. in flowing oxygen) makes it easy to prepare organic samples for the spectral analysis, of solutions. Due to the interaction of the plasma energetic particles some changes of polymer surface films as regards their chemical and/or physical character can occur [10—12]. In this way a modification of the polymer surface properties may induce an improved adhesion; plasma treatment also serves for etching and cleaning polymer surface films. In the case of textile fabrics plasma finishing may be used for. though it sometimes has only temporary effects e. g. friction coefficient changes. By exposure of the material to organic monomer vapours it is possible to achieve even its permanent change. Thus, the capacitively coupled discharges burning at low pressures may produce thin polymorphous films, e. g. polymorphous films on hygrometers (of the MIM system produced by applying sudies of electron emission due to a strong electric field). The reflexive films of clinical reflectors may likewise be protected against corosion.

III. DISCUSSION

Low temperature plasma research, namely high frequency plasma studies, make it possible to apply physical effects existing within the high frequency plasma to technological and plasmochemical processes. The unipolar and inductively coupled high frequency discharges and those burning under reduced pressure as well appear appropriate for technical use.

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