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Development and Approbation of HF Technological Ion Source for Inert and Chemically Reactive Gases.

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This paper represents a new type of technological ion source for ion - beam processing: the surface modification of materials, cleaning of surface, sputtering, coating of thin films, polishing, etc. The analysis of the literature shows that the most prospective from the point of view of plasma technologies are ion sources with operational regimes, based on electrodless HF discharge. The main technical advantage of HF ion sources is the absence of the cathode which prevents from using chemically reactive working gases and pollutes the ion beam by the products of it's erosion. The main concept of the working process of the new type ion source was proposed to be the resonance absorption of HF power due to the excitation of own volume plasma waves in HF discharge. The advantages of the chosen operational principle are the possibility of electrons heating in the whole plasma volume in contrary to electrons heating in near electrodes or near walls sheaths in capacitive and inductive modes of HF discharge and the possibility of electrons containment due to the presence of external magnetic field. In order to meet the requirements of surface modifications technologies where the low ion current densities are necessary the excitation of electrostatic waves in the plasma volume was utilized because their excitation was shown to be possible at any electron concentration contrary to the excitation of helicons which was possible at electron concentrations higher than threshold one. Moreover electrons were shown to be heated more effectively in the case of electrostatic waves generation then in the case of helicons excitation.

The development of the new type HF ion source included several stages:

1) the revealing of the conditions of electrostatic waves excitation and optimal regimes of HF low power input into limited magnetoactive plasma on the basis of plasma parameters measurement in the models of HF ion source under changes of working gases, pressure, power and frequency of the HF generator, the induction of external magnetic field and the gas discharge chamber length;
2) the design, manufacture and test of HF technological ion source (HF TIS) aimed at the increasing of it's efficiency;
3) hundred hours test of HF TIS;
4) test of ion beam density distribution for working gases: Ar, Xe, O_2, N_2, air.
5) approbation of HF TIS in plasma technologies.

Experiments showed that HF ion source with three grid concave type ion optical system is prospective from the point of view of plasma technology applications due to possibility of obtaining beams of inert (Ar, Xe, Kr) and chemically reactive gases (N_2, O_2, Air, etc.) with small amounts of impurities and minimized ion beam current losses on target. The range of extracted ion current densities is 0.05 ... 3.5 mA/cm^2, the diameter of spot with 90% uniformity at 40cm from the ion source is 16cm.