# NUMERICAL SIMULATIONS AND DESIGN OF THE RESONATOR CHAMBER OF MICROWAVE-ASSISTED CVD REACTOR

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One of the directions to obtain diamond films of high purity is a microwave-assisted plasma chemical reactor using chemical vapor deposition (CVD) synthesis [1-2]. It is possible to obtain diamond crystals and defect-free films using plasma heating near the substrate with powerful microwave radiation [3-4]. A careful approach is required when designing the excitation system of the resonator chamber from the microwave oscillation source. One of the most commonly used commercial plasma reactors is the cylindrical reactor, which uses a $TM_{011}$ mode and an electrical type system with a disk-shaped probe. Microwave energy is injected through the bottom of the resonator.

The design of the resonator chamber is shown in Figure 1a. Modification of the upper part of the resonator made it possible to concentrate areas with maximum electric field strength directly near the substrate. The shape of the cavity *1* above the substrate is optimized. The tuning element is a movable piston above the substrate, which changes the size of the cavity *2* to find resonance. Quartz ring *3* is located between two flat surfaces away from the area of high plasma concentration.

Numerical modeling of field distribution in the cylindrical resonator using CST Studio Suite was performed to find the optimal design of chamber. In addition to the main mode $TM_{011}$, this resonator also contains secondary radial maxima, which are associated with simultaneous excitation of the $TM_{021}$ and highest modes. The results of simulation of electric field strength distribution in the resonator at the input power of 1 kW are given in Figure 1b. Figure 1c shows the field distribution along the z-axis.

The optimal geometry of the disc-shaped resonator chamber is found. The maximum electric field strength in the vicinity of the substrate with the growing samples is achieved. To increase the stability of ignition of microwave discharge in the resonator chambers the movable piston is used. According to the simulation results the sample of the resonator chamber was machined and experimental studies were carried out. The power source is a magnetron of a microwave oven. The improvement of the magnetron consists of the using of the water cooling system. By powering the magnetron from a three-phase network, the obtained power in the load of at least 2.5 kW. Experimentally found steady-state plasma ignition modes at air pressures up to 10 Torr and plasma clot combustion at pressures of 30-80 Torr.

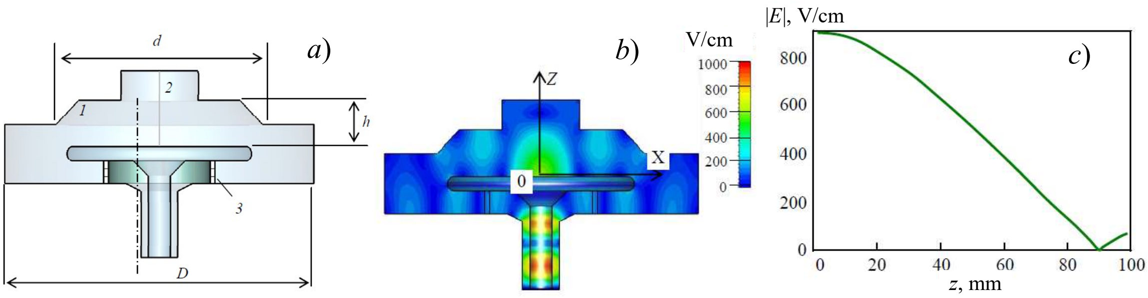


Figure 1 - Resonator chamber design (a); distribution of the electric field in the cross section of the resonator chamber (b) and distribution of the field along the z-axis at a power input of 1 kW (c).

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