NEW GYRO-DEVICE SYSTEMS FOR MILLIMETER-WAVE PROCESSING OF MATERIALS

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Application of the millimeter-wave energy for materials processing has been discussed and experimentally validated by many teams for years. The feasibility of the millimeter-wave power in this field of technology depends strongly on the development of facilities best serving the needs of researchers involved in various areas of materials science. The Laboratory for Microwave Processing of Materials in the Institute of Applied Physics has been focusing on the development of gyro-device systems designed purposely for investigations into characteristic features of processes based on interactions of millimeter waves with materials [1]. As a result, the range of millimeter-wave systems has been widened by introducing new facilities which offer more affordable opportunities for research.

It is well known that tunable frequency microwave sources make it possible to obtain more uniform microwave energy distribution in an applicator and to avoid the temperature runaway which is considered as one of the main drawbacks of microwave heating. A gyro–backward wave oscillator (gyro-BWO) with 2.5 kW cw output power at 24 GHz and tunable within (+/-) 0.5 GHz has been developed recently [2]. A special corrugated waveguide structure is used in the oscillator and frequency tuning is implemented by varying the magnetic field strength in the interaction region of gyrating electrons with the electromagnetic wave. The efficiency of the device can be increased using an electrically insulated resonator structure powered by a low-current power supply, which allows additional electron energy takeoff. The main performance features of both the oscillator and the gyro-BWO based system are presented.

A new model of the recent 3 kW cw 24 GHz system [3] has been developed on the basis of a gyrotron with a permanent magnet. The gyrotron operates at the second harmonic of the electron cyclotron resonance. The use of Nd-Fe-B alloys makes the permanent magnet really compact. The stationary magnetic field matches the resonance frequency of the oscillator by fine adjusting the small additional coil current.

Both gyro-device based systems incorporate a set of power supplies, a transmission line, and PC-control, and extend the line of the millimeter-wave sources designed as a versatile and user-friendly tool for research in microwave energy applications.

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