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Electron Accelerator for R&D Study and Radiation Processing

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Upgrading of radiation facility located at Institute of Nuclear Chemistry and Technology (INCT) in Warsaw has been performed towards higher technical and economical effectiveness, better operational characteristics suitable for radiation processing and research programs. The radiation facility located at INCT was established in 1993, when 10 MeV, 10 kW linear accelerator powered by magnetron was installed in separate building and equipped with appropriate conveyer system. During facility exploitation the spare parts availability and cost become major problems to achieve continuous services required by facility customers.

The objective of the project partly supported by IAEA was construction 10 MeV, 10-15 kW linear electron accelerator equipped with the microwave source based on TH 2158 klystron (Thales, France), and standing wave accelerating section (manufactured by NIIIEFA, St Petersburg, Russia).

The following stages of the design have been followed: electron gun, microwave system of accelerator, auxiliary systems including klystron stand, pulse power supply stand, driving generator stand and waveguide system, control, vacuum and water cooling systems. The triode electron gun with spherical impregnated cathode was selected as a source of electrons. The gun parameters were optimized to meet requirements of standing wave accelerating structure (distance between cathode and grid, distance between grid and anode, additional beam focusing to obtain proper beam dimensions). The nominal parameters of accelerator gun: 0,3 A; 50 keV; pulse repetition rate up to 300 Hz; pulse duration 20 μ s.

Fiber-optic synchronization and triggering circuit based on pulse generator as reference source were applied as triggering track of electron gun modulator, klystron modulator, and microwave amplifier. Klystron modulator was designed on the based of semiconductor switch (current load 1600 A, with voltage up to 18 kV). The modulator has been constructed to fulfill requirement of TH-2158 klystron including safety (shutdown) circuit for protection against current overload which may appear at semiconductor switch. The modulator is switched off, and modulator load current falls to zero if value of overload current surpasses 900 A.

The microwave system of the accelerator is composed from standard S-band microwave including microwave isolator which was used to separate klystron against reflected wave after breakdown occurs in accelerating section. SF6 isolation gas is used in waveguide elements to improve isolation properties. The main accelerating section parameters are as follow: electron energy 10 MeV, energy spectrum ± 2 %, average beam power in the range 10-15 kW, pulse microwave power <5 MW, frequency 2856 MHz, electrical efficiency up to 58 %, electron beam capture coefficient up to 85 %, pulse output beam current 210 mA in nominal conditions.

Accelerator control system is equipped with Siemens microprocessors and modules type Simatic S7-300, with communication channel Profibus and as SCADA tool (Supervisory Control And Data Acquisition) WinCC. The vacuum system consists of three ion vacuum pump type (pumping velocity 60 l/s) and turbomolecular vacuum pump which is used to start ion pumps at certain vacuum level. Accelerator is installed in vertical position and equipped with beam scanner 60 cm wide.

Country/Organization invited to participate

Poland

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