



APT-100 ICP/RF plasma system

Application: The 2nd generation ICP/RF (radio frequency) plasma system with regulated up to 50 kW power in plasma plume is developed for continuous operation on different gases, including Ar, air, N₂, blends of air and O₂, Ar + O₂, Ar + N₂, and others with pressure at the torch output from several Torr to 7 bar. The system allows remote plasma initiation at 1 bar pressure, visualization of the operation parameters as plate voltage and current, grid current, consumed from grid power, temperature and flow of water in three cooling loops, real plasma power.

Components: The plasma system consists of a High Voltage (HV) Module with dimensions 30" x 42" x 60", weight 970 kg; Radio-Frequency (RF) Module with dimensions 32" x 32" x 60", weight about 300 kg; coaxial cable 2.7 m; Matching Network 12" x 12" x 25", and plasma torch. Optional gas supply system for two or three gases with dimensions 4" x 4" x 6" and pre-installed calibration for 6 gases is available.

Parameters:

- Input voltage – 3 x 480VAC, 60 Hz (3 x 380VAC, 50 Hz and other are available)
- Input power – max 87 kW (125 A, AWG 2 for 480 VAC and 150 A for 380 VAC)
- Output voltage – up to 14,400 V
- Frequency – 5-7 MHz depending on application and product destination
- Cooling water – input 3/4" NPT female, output 1" NPT female. Flow rate for full power operation is 35-45 liters per minute
- Plasma gases flow – from 0.5 to 5 g/s (depending on gas composition and power)
- Torch dimensions : OD 5.5" (140 mm), length 14" (356 mm).

Control system.

- Standard control system provides manual operation and main parameters visualization, as anode voltage and current, grid current, anode and plasma power, input and output water temperature, water temperature after tube, and water flow rate on two text displays
- Advanced control system allows selection of manual and automatic operation modes from a 7- or 12-inch touch screen. Additionally to a set of functions for the standard system, we are the first in the field to offer automatic ignition, plasma stabilization, data logging, smooth power control, gas valves monitoring, diagnostic tools with numerous user prompts, and many others.

Front panels of DC modules with standard and advanced control systems are depicted in Fig.4 and Fig.5 correspondingly.

Prospective applications :

- (1) Advanced and economical test facility for the Ablative Thermal Protection Systems (TPS) materials. Compared to well known arc-jet facilities based on direct current (DC) torches, the 2nd generation RF plasma provides such advantages, as much better uniformity of the temperature and velocity fields in a plume cross section,

significantly larger plume OD with lower power consumption, contamination-free plasma, longer service time due to electrodeless design, wider range of plasma/test gases, continuous (thousands of hours) non-stop operation, and others. The test bed should provide experiments with materials for velocity >11.5 km/s (Earth return), with requirements to survive heat fluxes of 1.5–2.5 kW/cm², with radiation contributing up to 75% of that flux, and integrated heat loads from 75–150 kJ/cm².

- (2) Synthesis of new materials - solids and gases
- (3) Gasification of different feedstock - coal, sewage sludge, etc.
- (4) Powders processing.

Services: development, production, commissioning, and worldwide service of technologies based on ICP/RF plasma within the power range 30-500 kW.

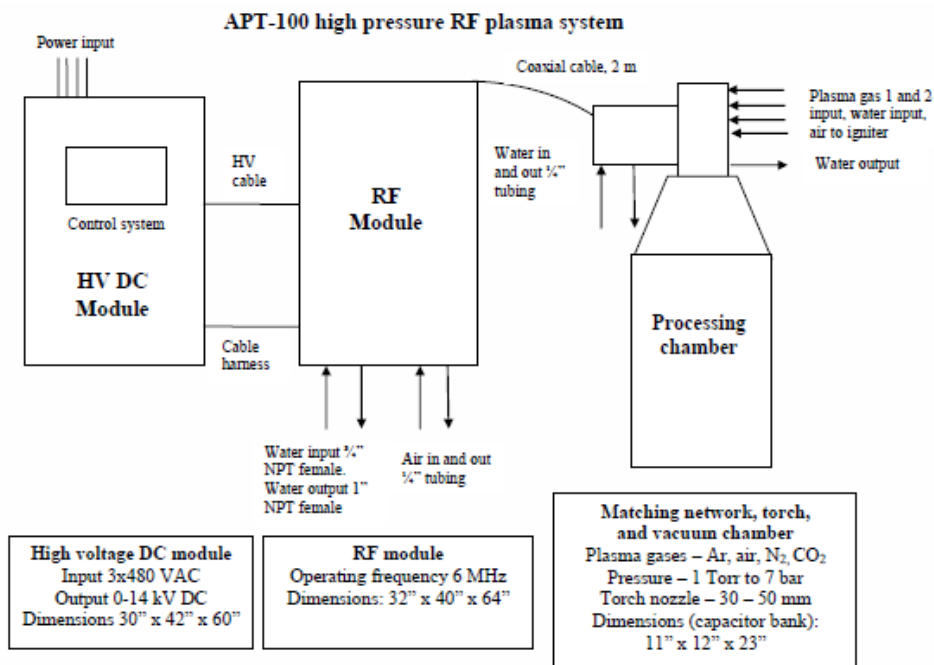


Fig.1. Configuration of a test bed for characterization of thermal protection materials.

	Parameter	Value
1	Flow OD at the torch output (before supersonic nozzle), mm	30–50
2	Plasma gases	Ar, air, N ₂ , CO ₂ , oxygen enriched air, other
3	Test gas flows, g/s	0.5–5.0
4	Free stream enthalpy, MJ/kg	3.0–40.0
5	Free stream velocity, M	0.02–7.0
6	Average test gas temperature, °C	2,000 – 6,000
7	Operation pressure (pressure in induction section)	1 Torr to 7 bar
8	Stagnation pressure maximal, kPa (mBar)	80 (800)
9	Maximal power consumption, kW	90



Fig.2. General view of the 100 kW ICP/RF plasma system for material tests.

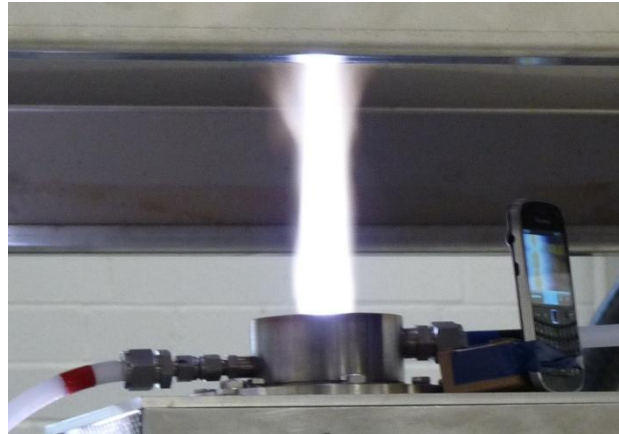


Fig.3. 30 mm OD plasma plume. Gas – air.



Fig.4. General view of the APT-100-3 DC module with standard control and 3-gas supply systems



Fig.5. General view of the APT-100-3 DC module with advanced control system