



APT-100 ICP/RF plasma system

Application: APT-100 is the 2nd generation ICP/RF (radio frequency) plasma system with regulated up to 40-50 kW power in plasma plume (depends on many factors, including plasma gas) is developed for continuous operation on different gases, including Ar, air, N₂, CO₂, 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 control, including plasma initiation at 1 bar pressure, automatic switching of plasma gases, 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, data logging, etc.

Components: The plasma system consists of a High Voltage (HV) Module with dimensions 30" x 42" x 60", weight 800 kg; Radio-Frequency (RF) Module with dimensions 32" x 32" x 60", weight about 300 kg; coaxial cable 2-2.7 m; Matching Network 12" x 12" x 25", and plasma torch. Optionally, available: (a) an external manual gas supply system for two or three gases with dimensions 4" x 4" x 6" calibrated for 6 gases, (b) internal computer controlled gas supply system, and (c) remote operator's console with 12" touch screen.

Parameters:

- Input voltage – 3 x 480VAC, 60 Hz or 3 x 380VAC, 50 Hz
- Input power – 90 kVA max
- Output voltage – up to 14,000 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 30-45 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, transition to different plasma gases, plasma stabilization, data logging, smooth power control, filament voltage control, gas valves monitoring, diagnostic tools with numerous user prompts, remote control from the operator's console or through profibus, and many others.

Front panels of the 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 for surface modifications, minerals extraction
- (5) NO and NH₃ production.

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

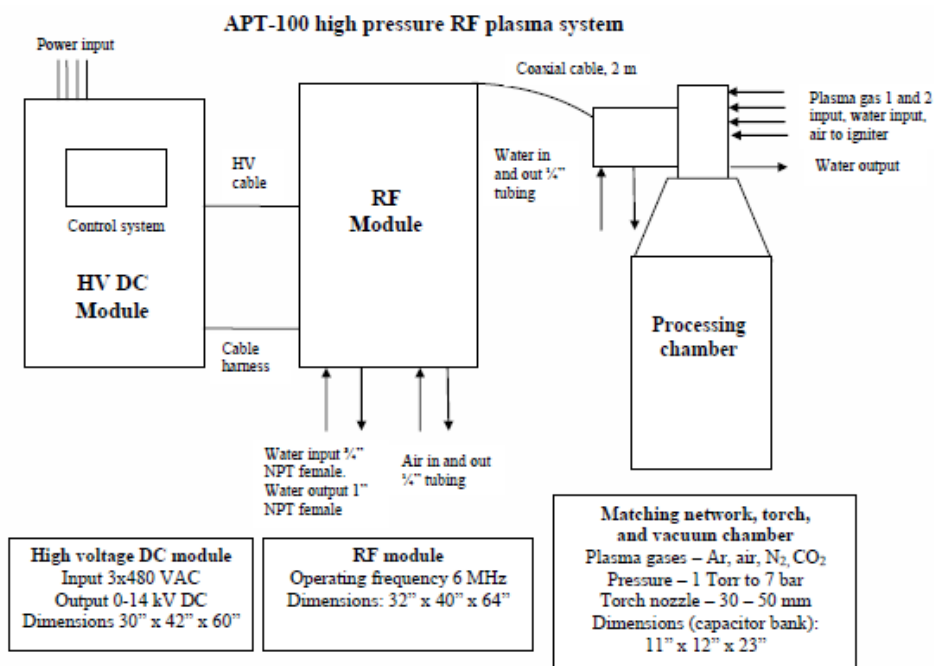


Fig.1. Configuration of a test bed for characterization of thermal protection materials.

	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	87



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



Fig.6. Remote operator's console



Fig.7. APT-100-3 operation and spectroscopy