

## OPD – Outside Plasma Deposition System

Main purpose of Outside Plasma Deposition (OPD) system is deposition of pure or fluorine-doped silica layers on the outside of a target bait. Normally, the target bait is a round or shaped (octagonal, hexagonal, D-shape, square, etc.) quartz rod. Key benefit of OPD technology is that each deposited layer is immediately vitrified into transparent glass. Since each deposited layer is very thin (approx.  $5\mu\text{m}$ ), vitrification process occurs at relatively low surface temperature ( $1450^{\circ}\text{C}$  –  $1700^{\circ}\text{C}$ ). Low vitrification temperature allows high incorporation rate of even very volatile materials such as fluorine. Fabricating glass with OPD allows deposition of layers with fluorine concentrations up to 4 mol%, corresponding to refractive index difference of approximately 0.020 or  $\text{NA}=0.25$  with respect to pure silica. Above mentioned characteristics make OPD an ideal technology for production of triple-clad laser fiber preforms or custom-made silica-silica fiber preforms.



### Description

OPD system uses a 10kW 2.4GHz microwave source with a rectangular waveguide system, isolator for protection from reflected power and a 3-stub waveguide tuner. A quartz glass torch is inserted through the waveguide at the standing-wave peak to ensure maximum power transfer from electromagnetic radiation to plasma column.

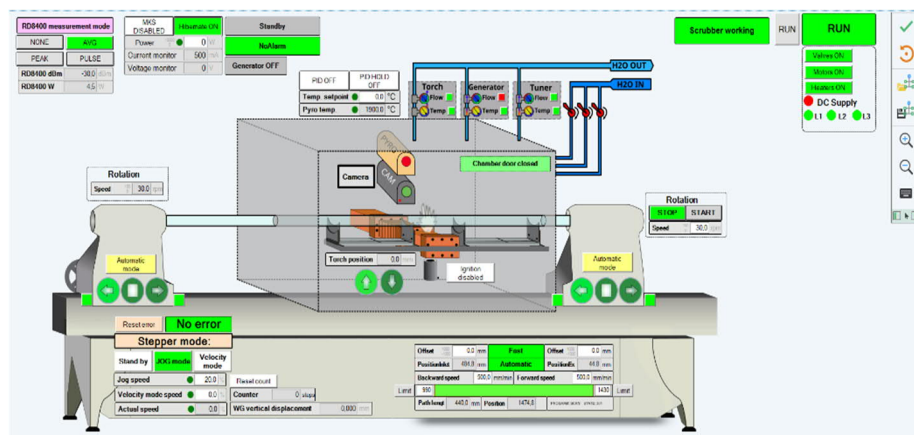
Process gases are prepared in a dedicated gas cabinet which includes Mass Flow Controllers (MFC), in-house developed  $\text{SiCl}_4$  evaporator and  $\text{SiCl}_4$  bulk refill tank together with other components for stable and reliable operation. Gases are delivered into the torch through a heated process delivery line where they react to form  $\text{SiO}_2$  soot particles and other species.  $\text{SiO}_2$  particles are deposited on a bait rod and are vitrified into transparent glass layer.

The waveguide with torch is surrounded by a closed metallic chamber that ensures safe operation. It prevents microwave leakage and provides extraction of  $\text{SiO}_2$  soot and other chemicals into chemical scrubber. Plasma chamber is positioned on a modified glass-working lathe with motorized rotation and translation.

All OPD subsystems are controlled from a central control cabinet which includes an Industrial PC (IPC), safety PLC and all control I/O units. A UPS unit is provided to put the machine into a safe state in case of a sudden electrical power shortage.

## Control system

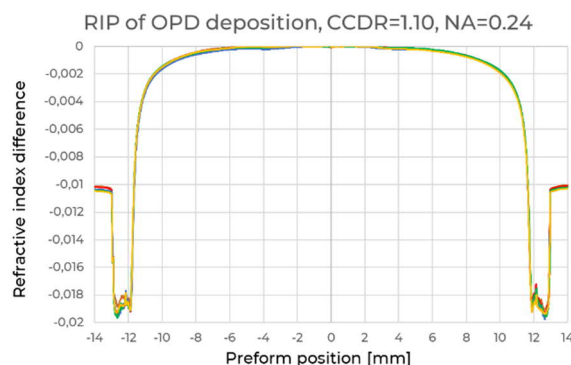
Control system and software is one of the key components in the fiber preform fabrication process. OPD system is controlled by OptiFACT system and software, offering advanced process control, extensive data logging, process data analyzer, recipe database, as well as remote update and servicing.



## Process capabilities

Parameter	Value
Quartz rod/bait length	max. 800 mm
Quartz rod/bait start diameter	10 – 40 mm
NA of deposited F-doped layer with respect to pure silica	max. 0.25
Maximum CDDR*	1.20
Deposition rate for pure SiO <sub>2</sub>	0.60 g/min
Deposition rate for NA = 0.20	0.25 g/min
Deposition rate for NA = 0.22	0.18 g/min
Deposition rate for NA = 0.25	0.12 g/min

\* Maximum CDDR depends on the starting rod diameter.



## Options and services

Plasil offers the following add-on options and services:

- H<sub>2</sub>/O<sub>2</sub> burner with necessary gas cabinet for in-situ glass assembly preparation. This option is ideal for customers who do not have a separate glass-working lathe where welding operations can be done.
- In case the customer desires to deposit glass layer onto a tube, an over-pressure is needed to prevent the tube to collapse during the deposition process. Plasil can provide solutions with precise inner tube pressure control.
- Besides equipment commissioning and process start-up, Plasil can provide product development support and technology transfer per customer request.
- Process training at Plasil's development lab.
- Using in-house OPD machine, Plasil can supply custom preform samples. More information about the deposition services can be found [here](#).

For more information about OPD equipment and technology please write to [info@plasil.si](mailto:info@plasil.si)

