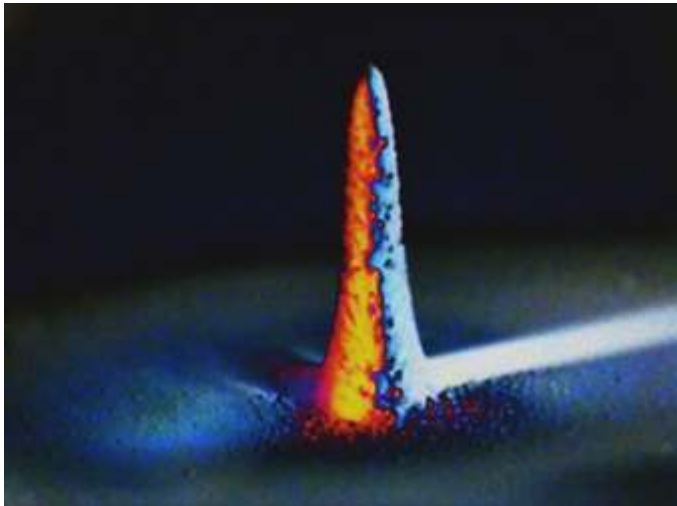

Micro-jet Plasma CVD



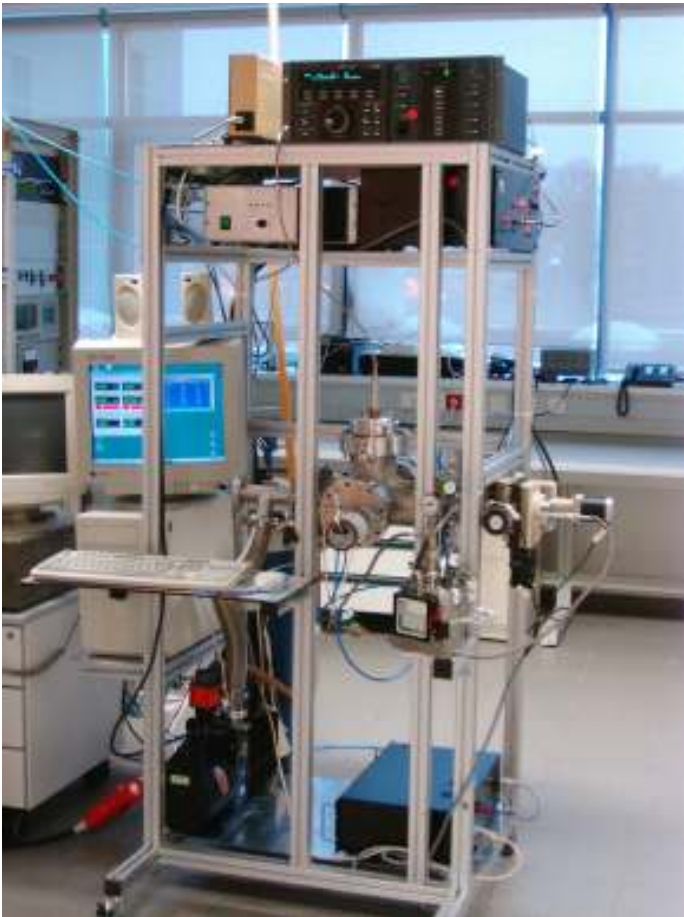
XII Workshop "Oberflächentechnologie mit Plasma- und Ionenstrahlprozessen"

Kamel Silmy

Mühlleithen 16-18.03.2005



Fraunhofer Institut
Angewandte
Polymerforschung



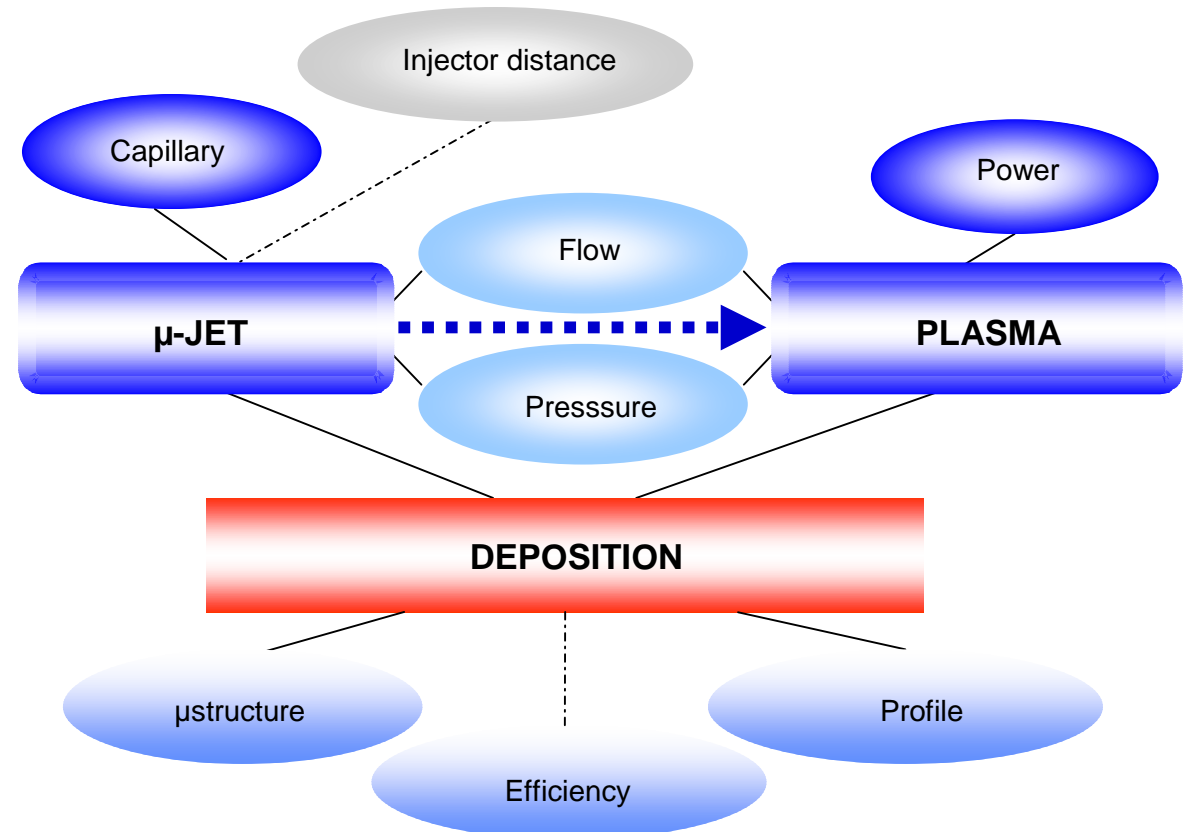
Content

- Overview of MJPCVD process
- Quartz-like deposition track
 - Optimal conditions
 - Range of deposition track
 - Chemical composition
 - Microstructure
- Outlook

Overview of MJPCVD process

- 5 distinct parameters:
 - Power input (P)
 - Deposition pressure (p)
 - Flow rate (F)
 - μ -capillary's size (length and inner diameter)
 - Injector distance (d)

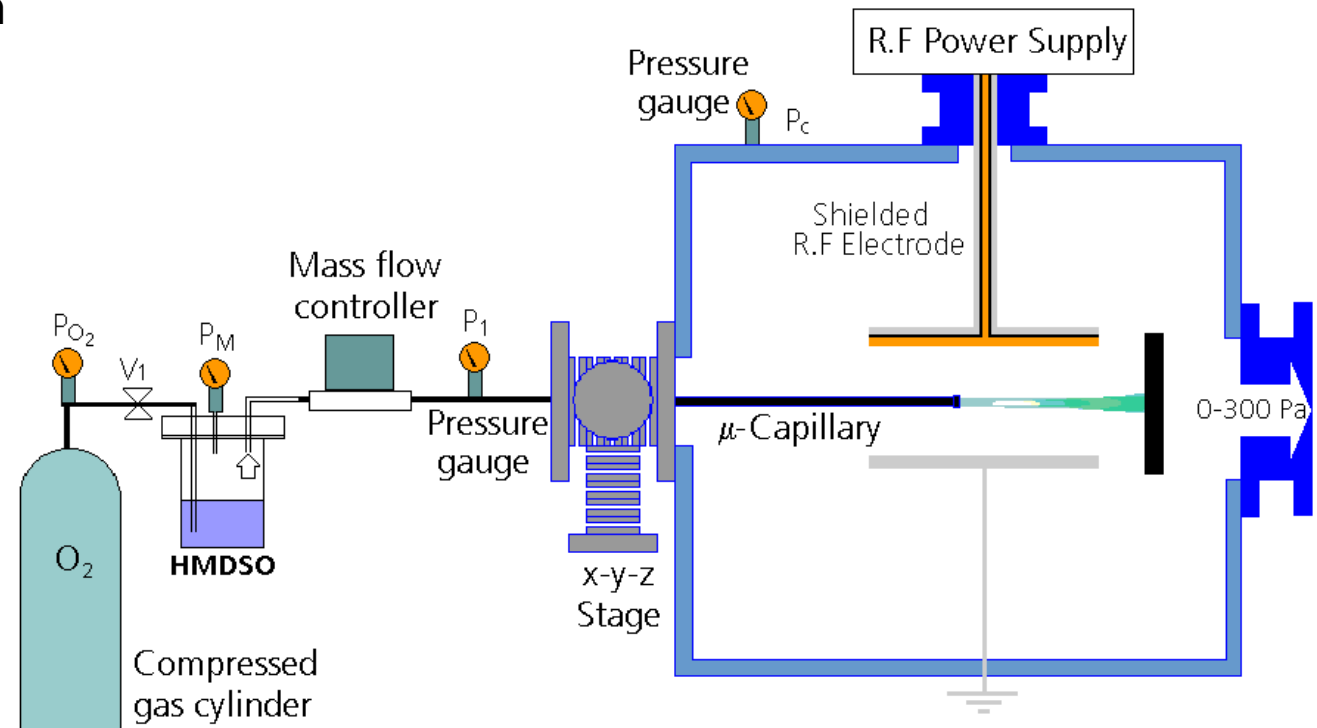
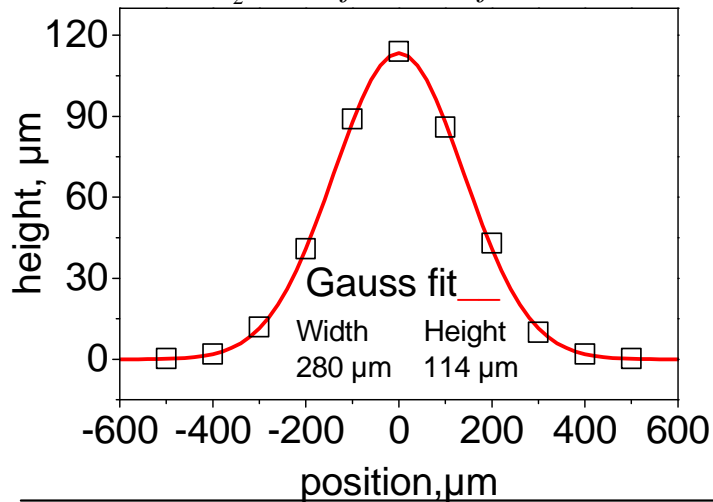
- 3 factors of MJPCVD process:
 - Shape of the deposition track
 - Morphologie
 - Average deposition efficiency



Sketch of MJPCVD system

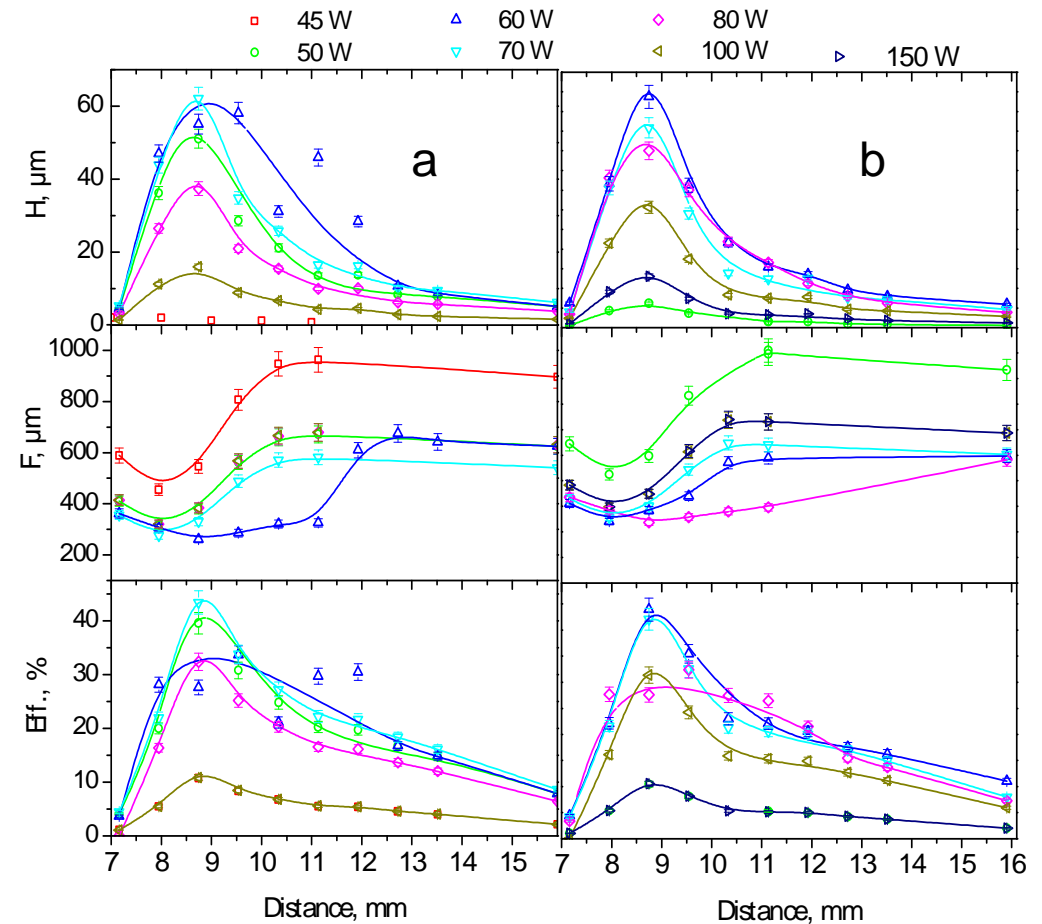
- Inter-electrode distance 2 cm
- Injector distance $d \in [0;20]$ mm
- capillary velocity $175 \mu\text{m/s}$
- HMDSO/ O_2 1:120 ($P_M=5$ bar)
- 1 cm deposition track

$$\text{Eff.}(\%) = \frac{\text{Quartz-like deposition mass}}{\text{SiO}_2 \text{ mass from the flow rate}} \times 100$$

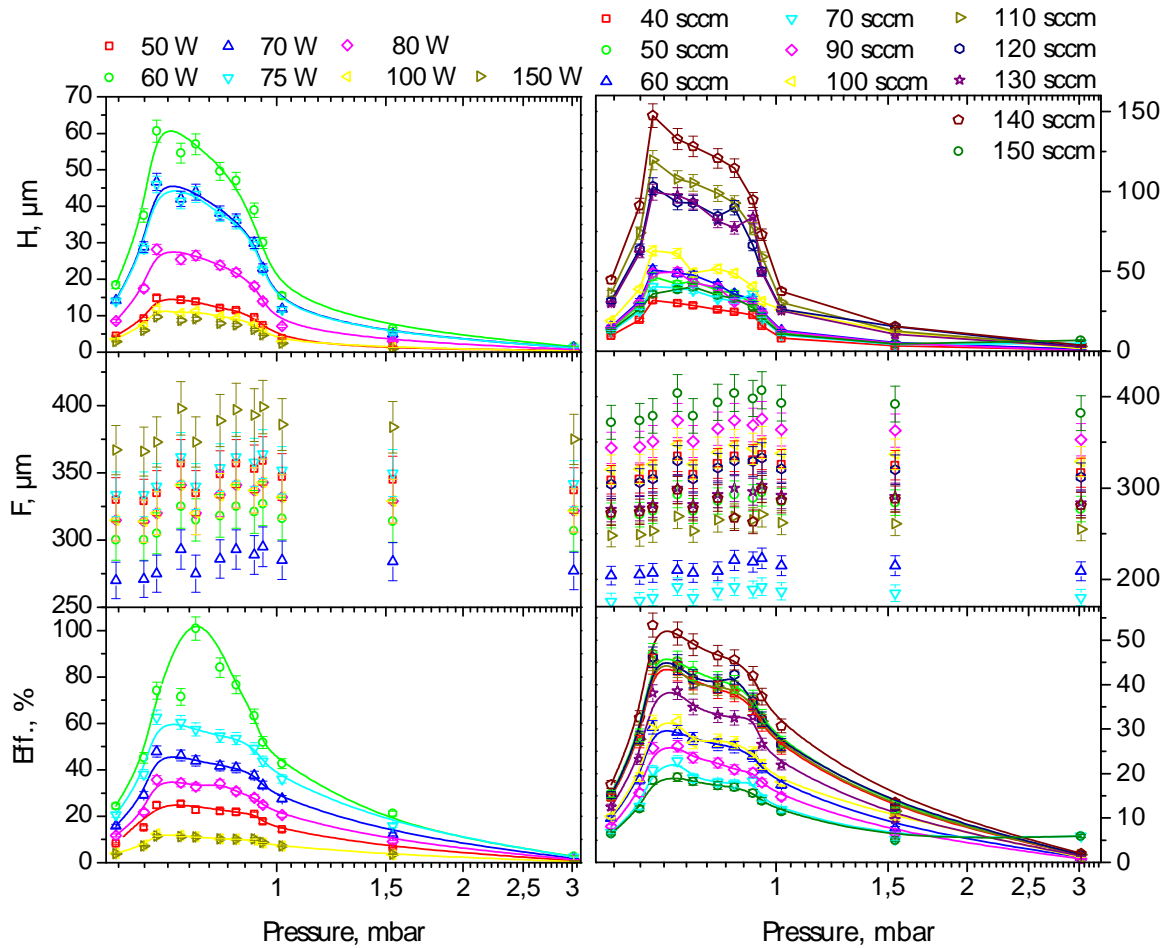


Optimal injector distance d_{opt}

- Capillary's size: $125 \mu\text{m} \times 5 \text{ cm}$
 - 50 sccm O_2/HMDSO (120:1)
 - 0-200 W
 - 0.72 mbar (a) and 1.52 mbar (b)
- Optimal deposition track as a function:
 - Power input
 - Injector distance
- Optimal injector distance $\neq f(\text{pressure})$



Optimal power & flow rate



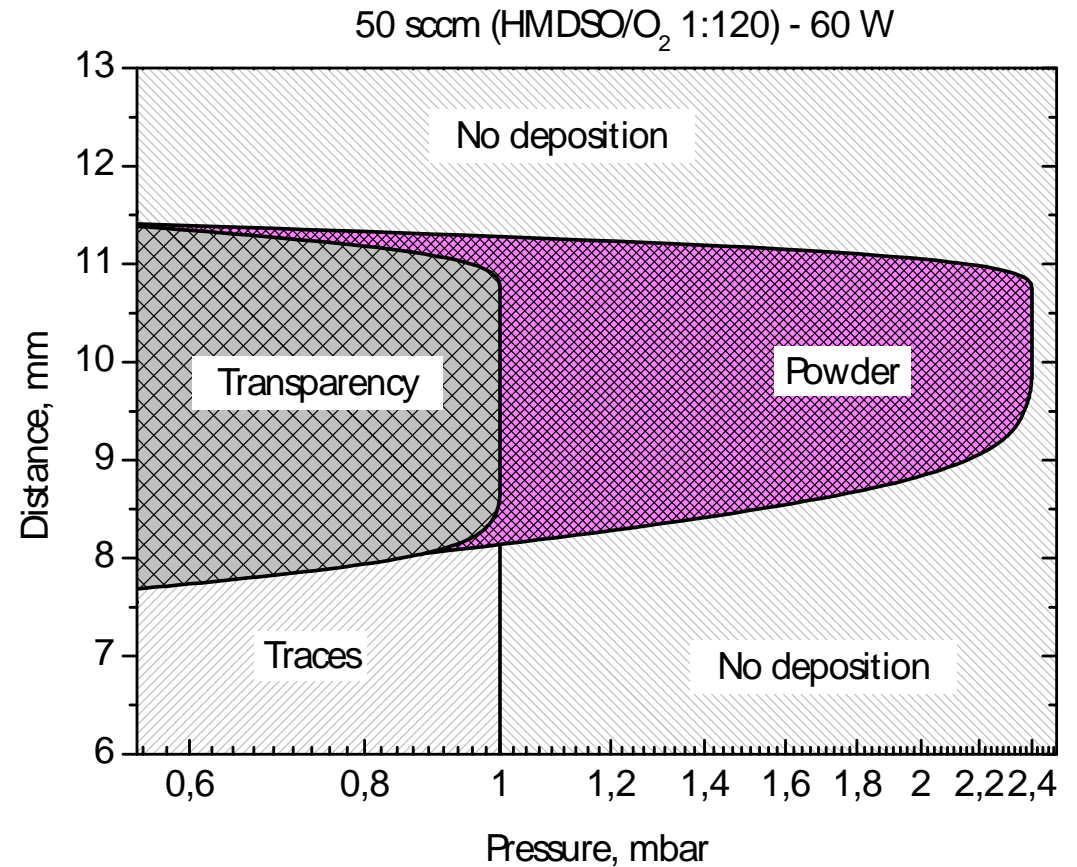
- Capillary's size: $125 \mu\text{m} \times 5 \text{ cm}$
 - O_2/HMDSO (120:1)
 - 8.75 mm injector distance (d_{opt})

- Optimal deposition depends on:
 - Power input ($P_{\text{opt}}=70 \text{ W}$)
 - Chamber pressure ($p_{\text{opt}}= \text{mbar}$)
 - Flow rate ($F_{\text{opt}}=70 \text{ sccm}$)

- $\text{FWHM} \neq f(\text{chamber pressure})$
- $\text{FWHM} = f(\text{flow rate; power})$

Map of Quartz-like deposition

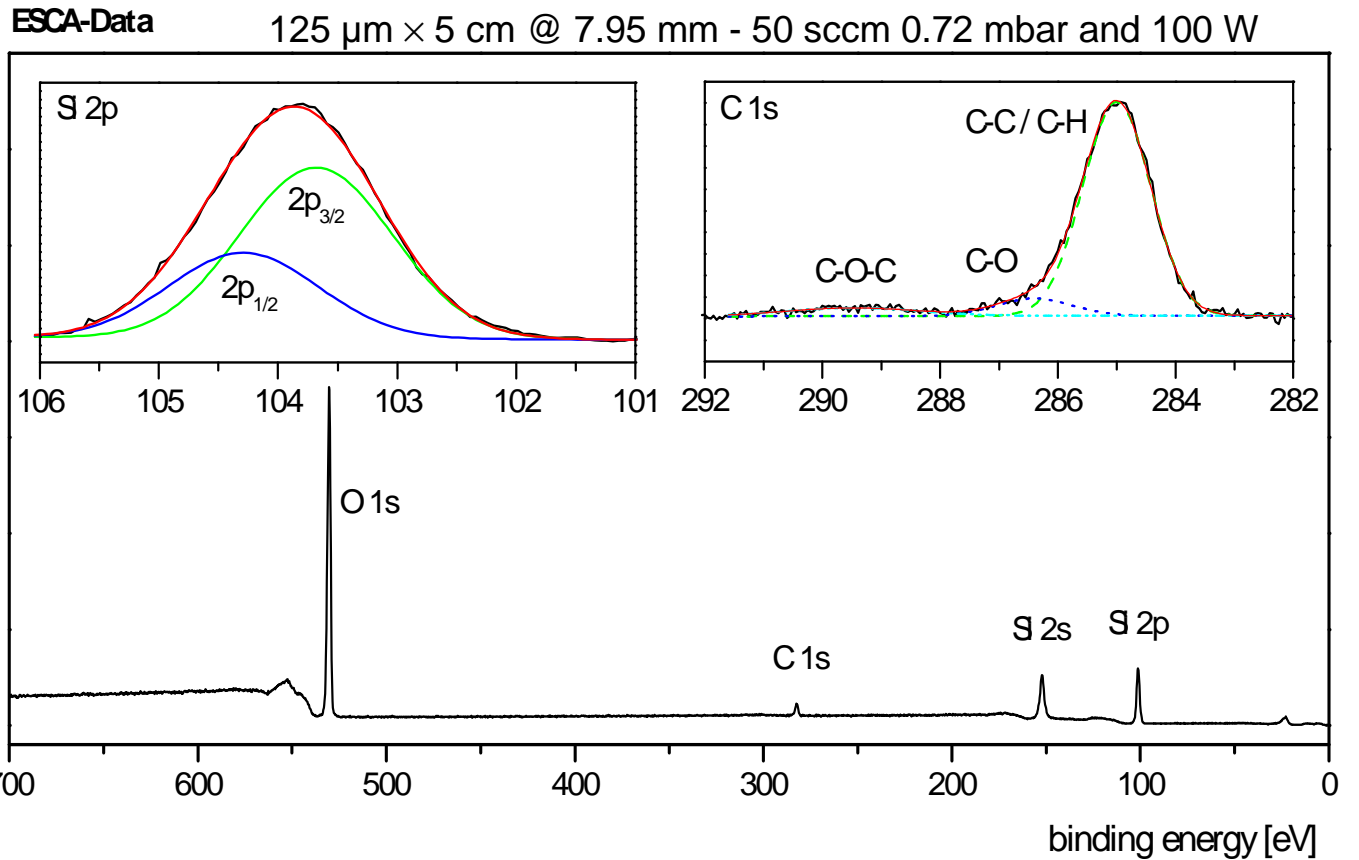
- Capillary's size: $250 \mu\text{m} \times 5 \text{ cm}$
 - 50 sccm O_2/HMDSO (120:1)
 - 60 W
- Transparent deposition:
 - Low deposition pressure
 - Injector distance $d \in [8; 11] \text{ mm}$
- No deposition:
 - deposition pressure $2.5 < p < 0.55 \text{ mbar}$
 - Injector distance $d \in [0; 7.8] \cup [11.5; \infty[$



Chemical composition of Quartz-like deposition

Si2p	C1s	O1s	
30.61	5.81	63.58	At%
103.67	284.96	532.0	Pos.eV

- Non existence of Si-C or C-Si
- Carbon presence from contamination
- Quartz-like deposition



Microstructure

60 W

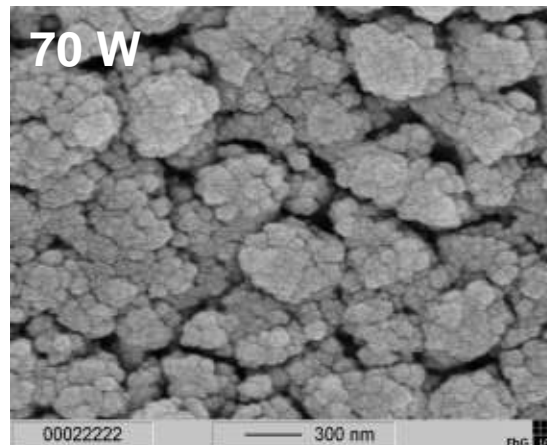
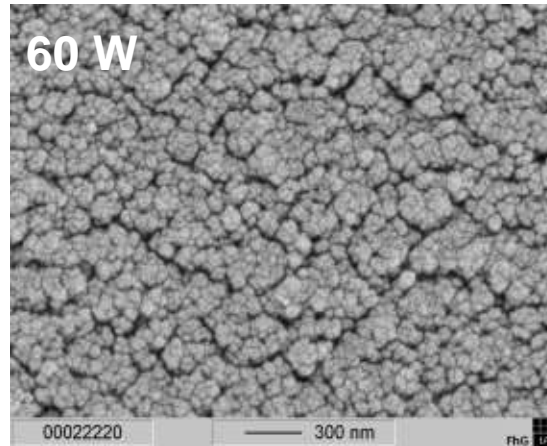
- relative homogeneous fine structure of spheres particles
- particles' size ~50 nm
- ground boundaries visibles

70 W

- cauliflower-like agglomerate particles of about 300 nm diameter
- particles' size ~50 nm

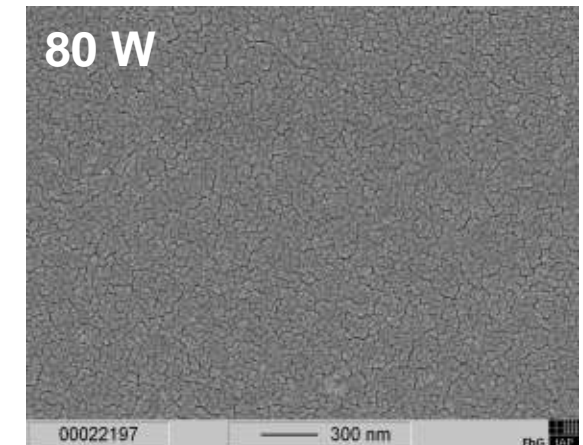
80 W

- particles-free matrix
- Cracks structure visible



Conditions of deposition

- 125 $\mu\text{m} \times 5 \text{ cm}$ @ $d=8.75 \text{ mm}$
- 50 sccm – 0.74 mbar @ various powers input



Outlook



- Quartz-like deposition carbon-free
- Deposition track's range partially highlighted
- Interaction μ -jet structure & plasma properties