

Molecular layer deposition and plasma deposition to produce functionalized silica

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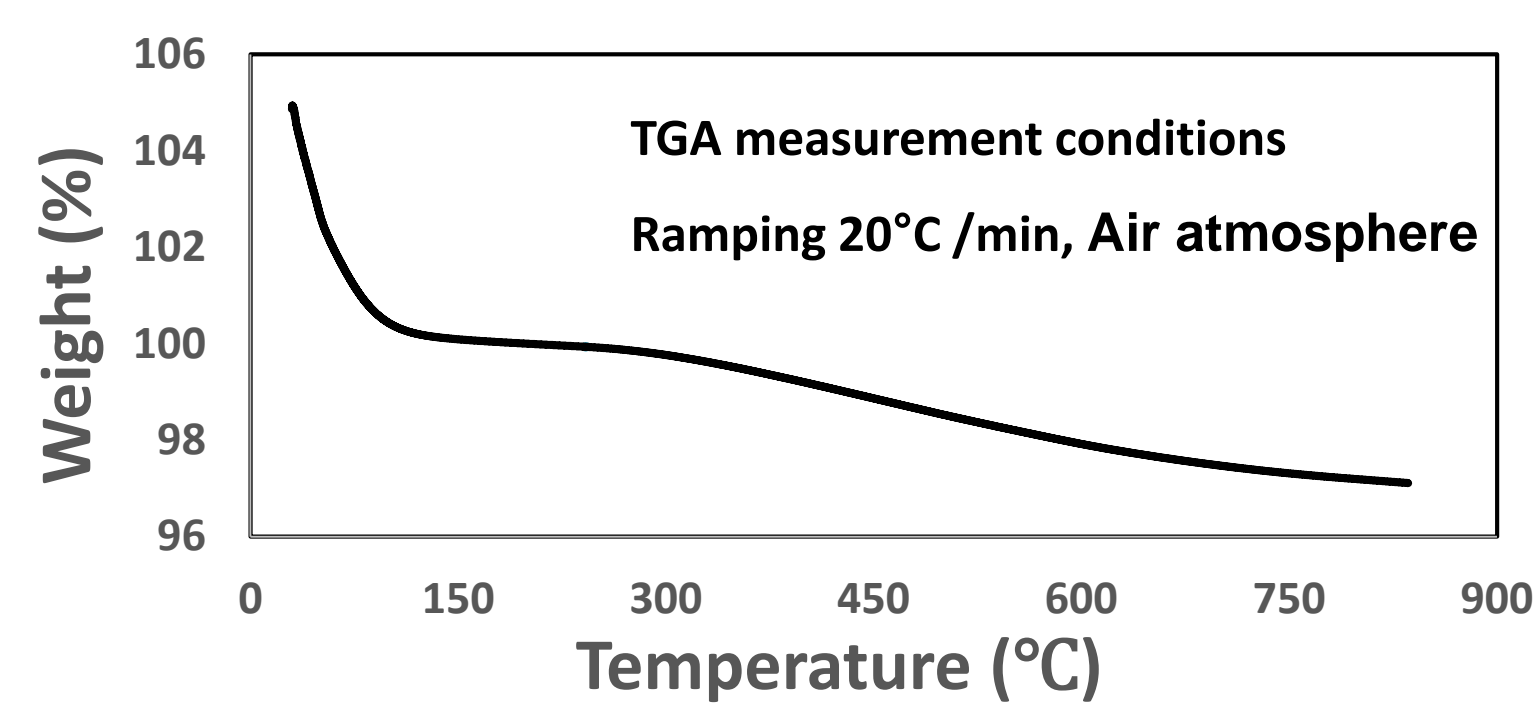
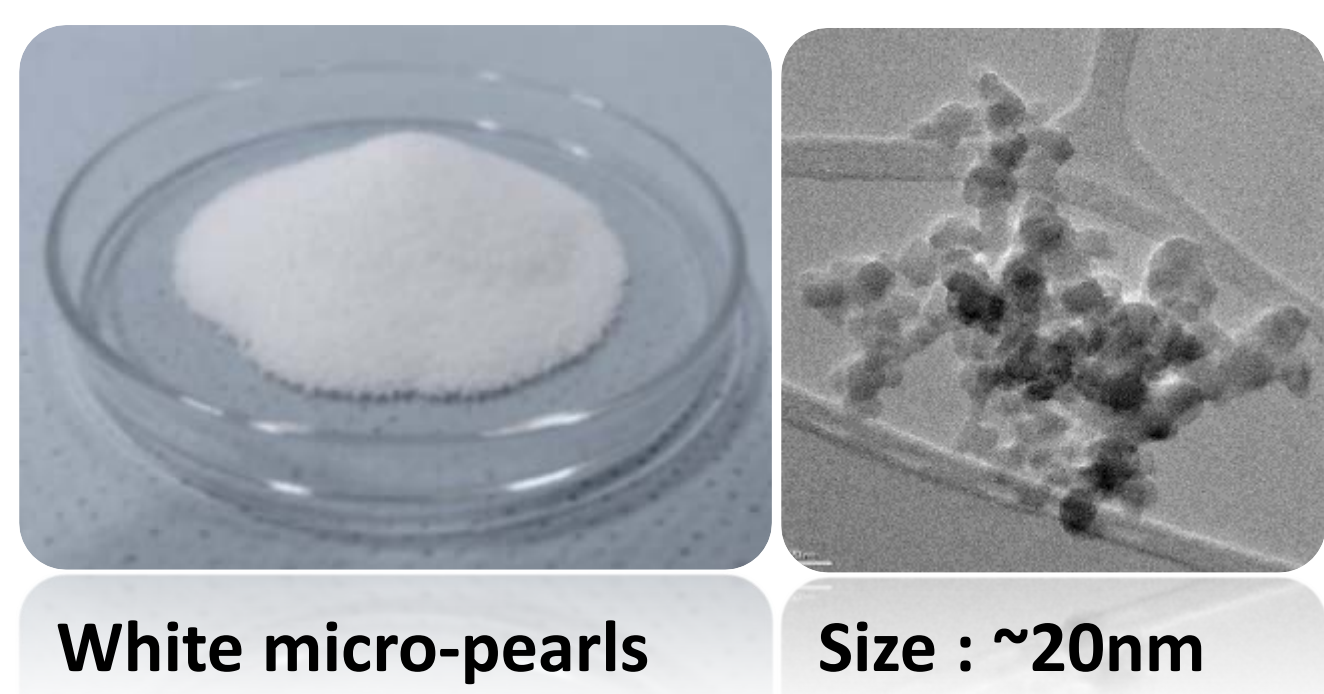
Introduction

The aim of this project is to investigate molecular layers of organic coatings deposited on silica particles – to make them directly compatible with tire elastomers – reducing the rolling resistance of the tires significantly, and thus the global energy consumption in automotive transportation.

Experimental setup

Silica : Ultrasil 7005

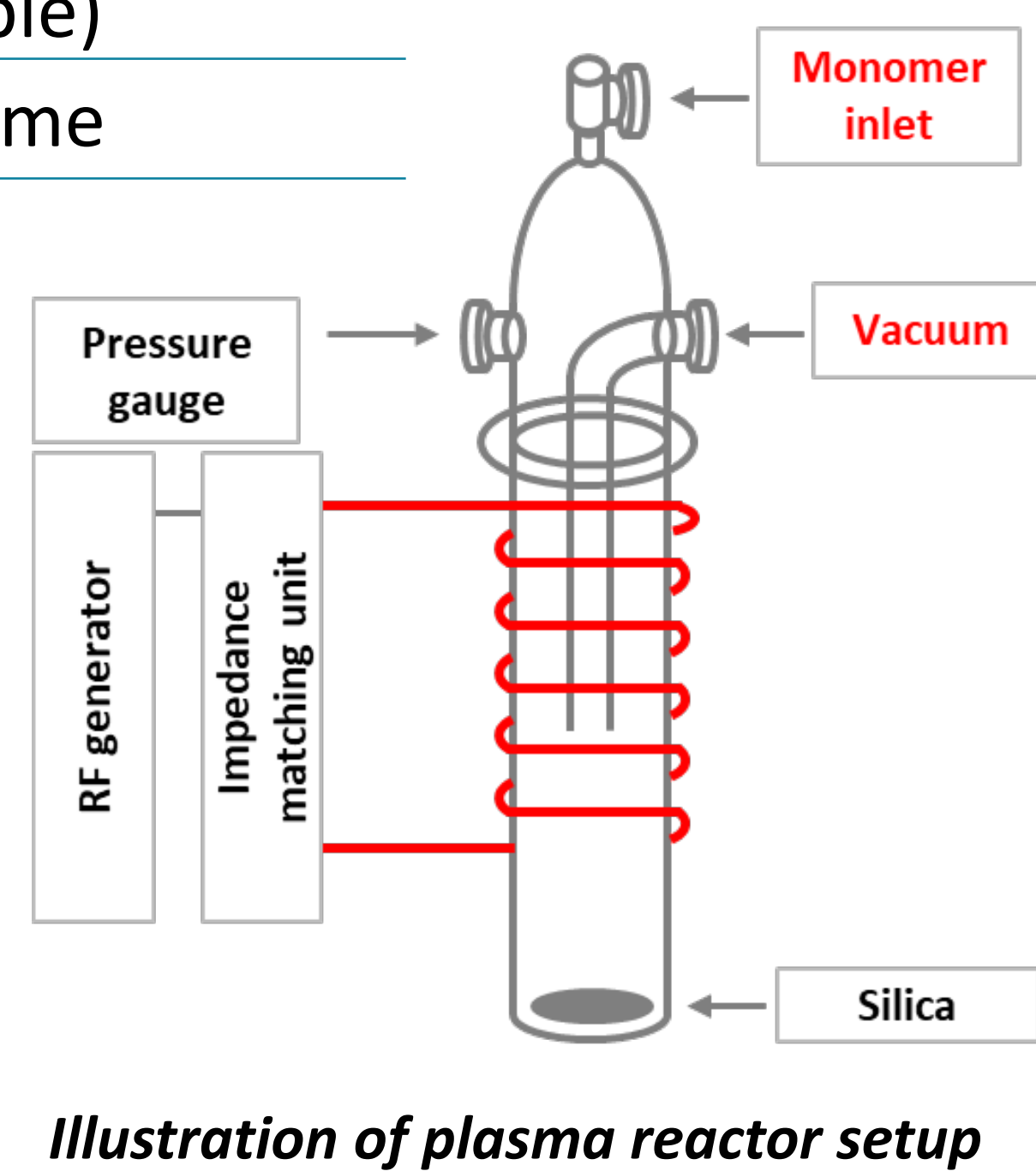
Specifications				TGA results		
BET surface area (N ₂)	CTAB surface area	Loss on drying 2h, 105°C	pH value	Water content (<200°C)	Weight loss (200~850°C)	Number of Silanol groups
m ² /g	m ² /g	%		%	%	SiOH/nm ²
190	>175	≤ 7	6.0	4.9	2.9	~10



Plasma treatment conditions

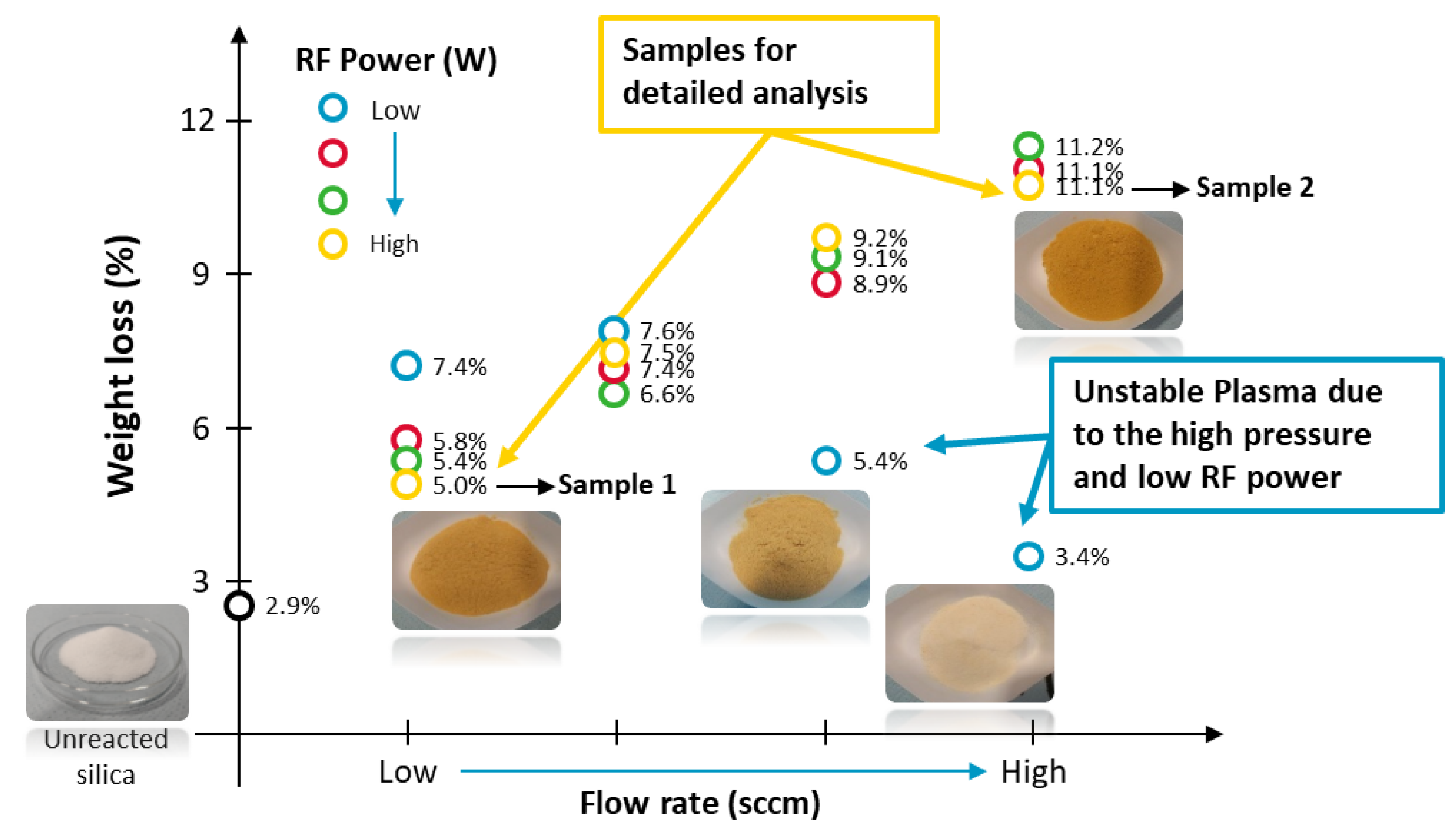
RF Power	Low to High (Variable)
Feed rate	Low to High (Variable)
Reaction time	Fixed time

* Type of precursor is confidential



Results and discussion

Thermogravimetric analysis (TGA)



X-ray photoelectron spectroscopy (XPS)

Sample	C %	O %	Si %	N %
Untreated silica	1.1	69.8	29.1	0.0
Sample 1	16.2	59.2	23.9	0.7
Sample 2	28.1	51.0	20.7	0.2

Transmission electron microscopy (TEM) analysis

Sample	Untreated silica	Sample 2
Elemental analysis (C:Green, Si:Red)		

Summary

- Plasma coated samples were prepared using a precursor and varying RF power and flow rate.
- Characterization of coated samples was done by analytical tools such as TGA, XPS, TEM.
- Deposition of a hydrocarbon layer was successful and highest degree of deposition was observed at high RF power and high flow rate
- Layer thickness was in the lower nm range, but difficult to measure precisely by TEM