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Chemical model of Ar/O_2 microwave plasma with nanoparticle formation from metal precursors

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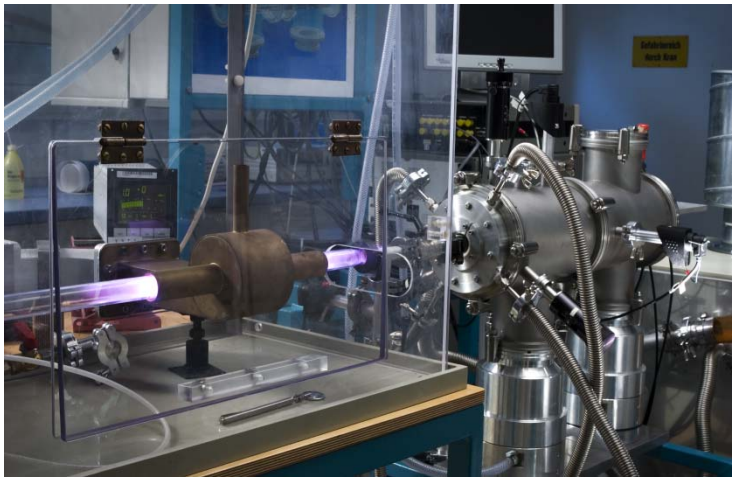


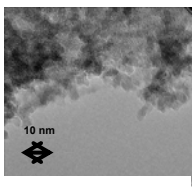
Flow tube with microwave plasma and particle mass spectrometer

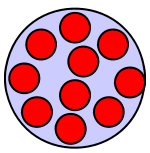
Reactions in the Ar/O_2 – system

ionization	$Ar + e^- \rightarrow Ar^+ + 2\,e^-$
attachment	$O_2 + e^- + M \rightarrow O_2^- + M$
charge transfer	$Ar^+ + O_2 \rightarrow O_2^+ + Ar$
recombination	$O_2^+ + O_2^- \rightarrow O_2 + 2\,O$
electr. excitation	$Ar + e^- \rightarrow Ar^m + e^-$
quenching	$Ar^m + M \rightarrow Ar + M$
reactions of neutral species	$O_2 + O + M \rightarrow O_3 + M$
	$O_3 + O \rightarrow 2\,O_2$

Mechanism of particle formation

$$Fe(CO)_5 \rightarrow \rightarrow FeO_2 + FeO \rightarrow Fe_2O_3$$
$$FeO_2 + FeO_2 \rightarrow Fe_2O_3 + O$$

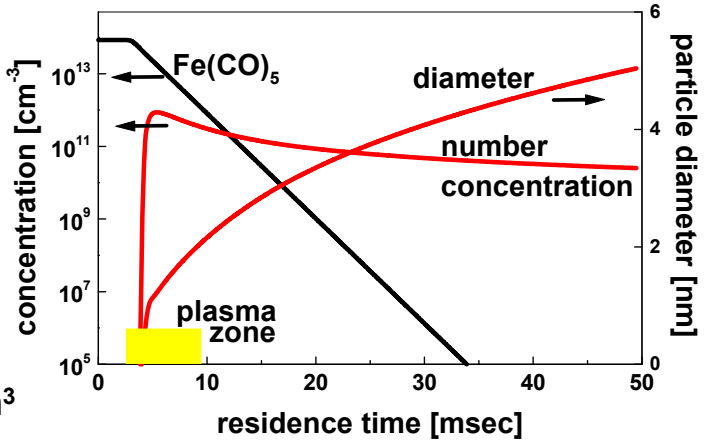


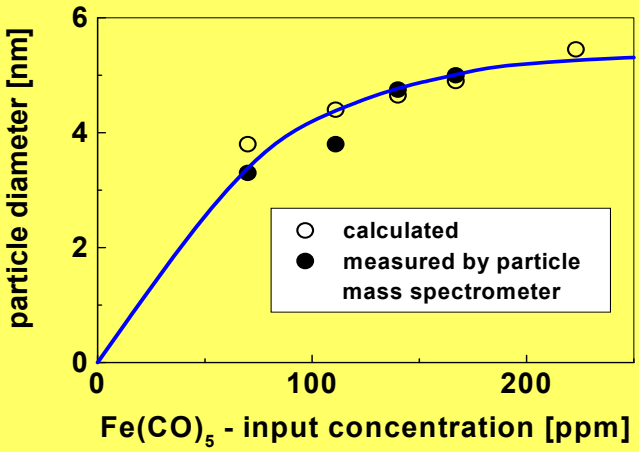


coagulation
d N/dt = - k · N^2
k ≈ 10^{-10} ... 10^{-9} cm^3/sec

10 monomers
primary size 1 nm
ρ = 4.5 ... 4.8 g/cm^3

Calculated time profiles





Conclusions

- particle size depends strongly on input concentration and on residence time
- good agreement between model and particle mass spectrometer results
- model is applicable to a wide range of conditions and substances