Plasma Surface Modification of Zeolites with Gas Phase Diagnostics

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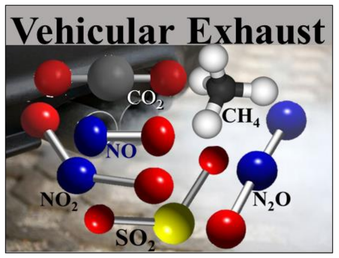
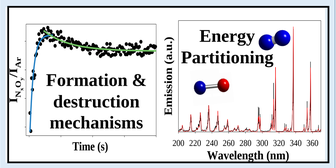
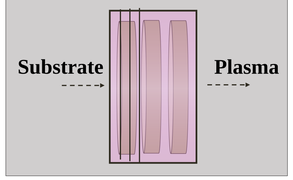


"Solving these challenges requires developing an understanding of the fundamental plasma–surface interactions in an integrated approach that combines new computational strategies and ***diagnostic techniques***." – 2017 Plasma Roadmap

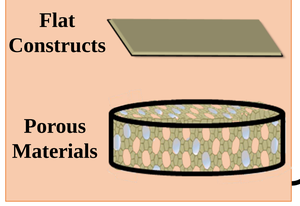
Gas Phase Studies



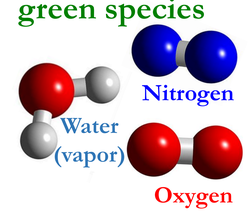
Gas - Surface Interface



Substrate Selection

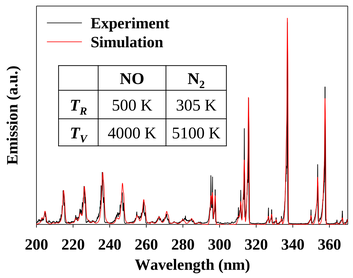


Conversion to green species

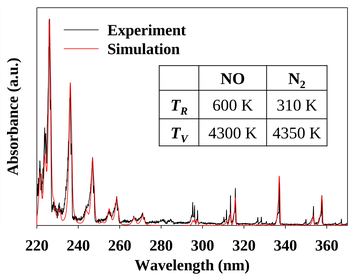


Gas Phase Studies

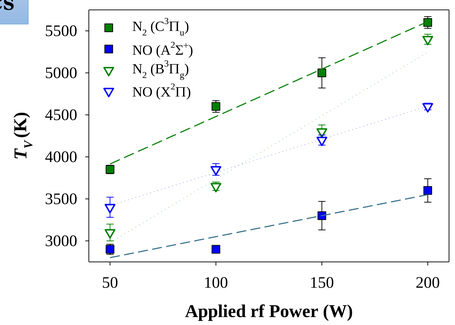
Steady State Energetics



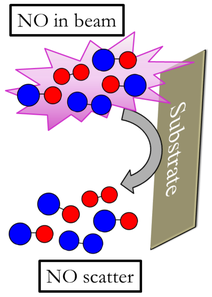
	NO	N_2
T_R	500 K	305 K
T_V	4000 K	5100 K



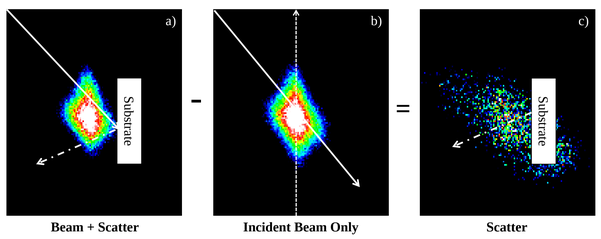
	NO	N_2
T_R	600 K	310 K
T_V	4300 K	4350 K

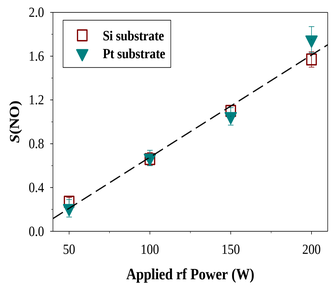


Surface Scatter

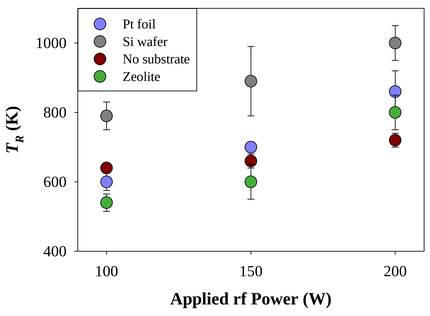


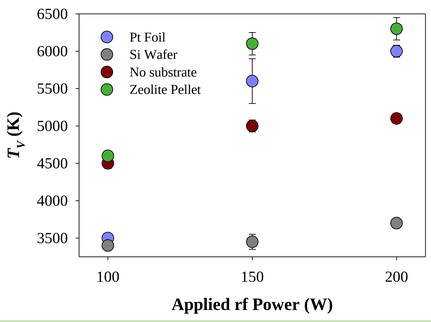
S = 1: 100% scatter





Spectroscopy with Substrates



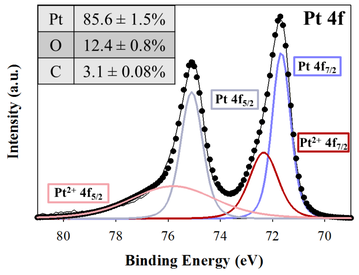


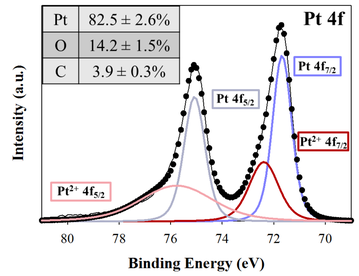
Presence of catalytic substrate does not dramatically affect rotational cooling pathways

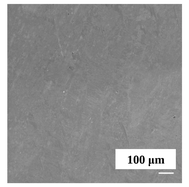
Catalytic substrates appear to result in higher T_V(NO) at higher plasma powers.

Substrate Studies

Platinum Foil







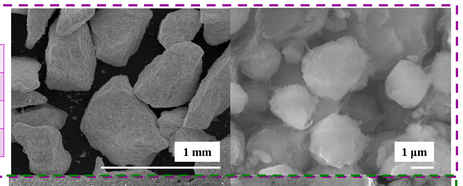
The atomic composition & morphology of Pt foil remained unchanged after N_2O plasma exposure.

Zeolites

Untreated

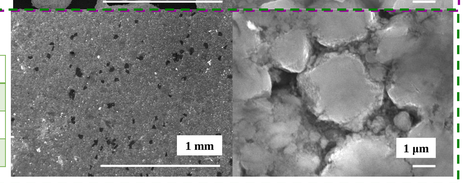
Native Zeolite

O	59.9 ± 1.2%
Si	22.3 ± 0.12%
C	11.8 ± 1.3%
Al	6.0 ± 0.03%



Zeolite Pellet

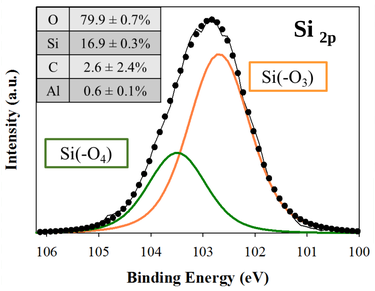
O	53.9 ± 0.04%
Si	18.2 ± 0.02%
C	22.4 ± 0.01%
Al	5.5 ± 0.04%

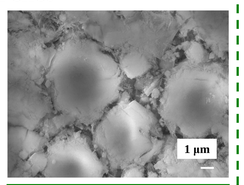


NO Plasma Treated

Zeolite Pellet

O	79.9 ± 0.7%
Si	16.9 ± 0.3%
C	2.6 ± 2.4%
Al	0.6 ± 0.1%





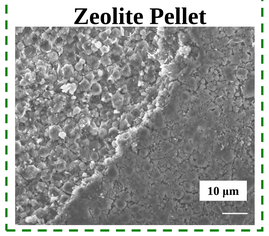
Porous morphology is maintained

C_2F_6 Plasma Treated

Assess surface modification of high surface area materials with a depositing precursor.

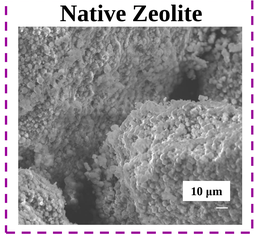
Top of pellet shows FC film formation, while porous morphology is present at edge

Zeolite Pellet

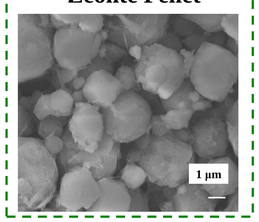


H_2O Plasma Treated

Native Zeolite



Zeolite Pellet



Future Directions

What do temporally- and spatially-resolved spectroscopy data reveal about underlying plasma phenomena?

How does the morphology of a substrate influence steady-state surface coefficients?

Can we tailor the surface features of materials for catalysis applications?

Acknowledgments

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