SAND2010-0224C

Lithographically Patterned Pyrolytic Carbon Electrochemical Electrodes

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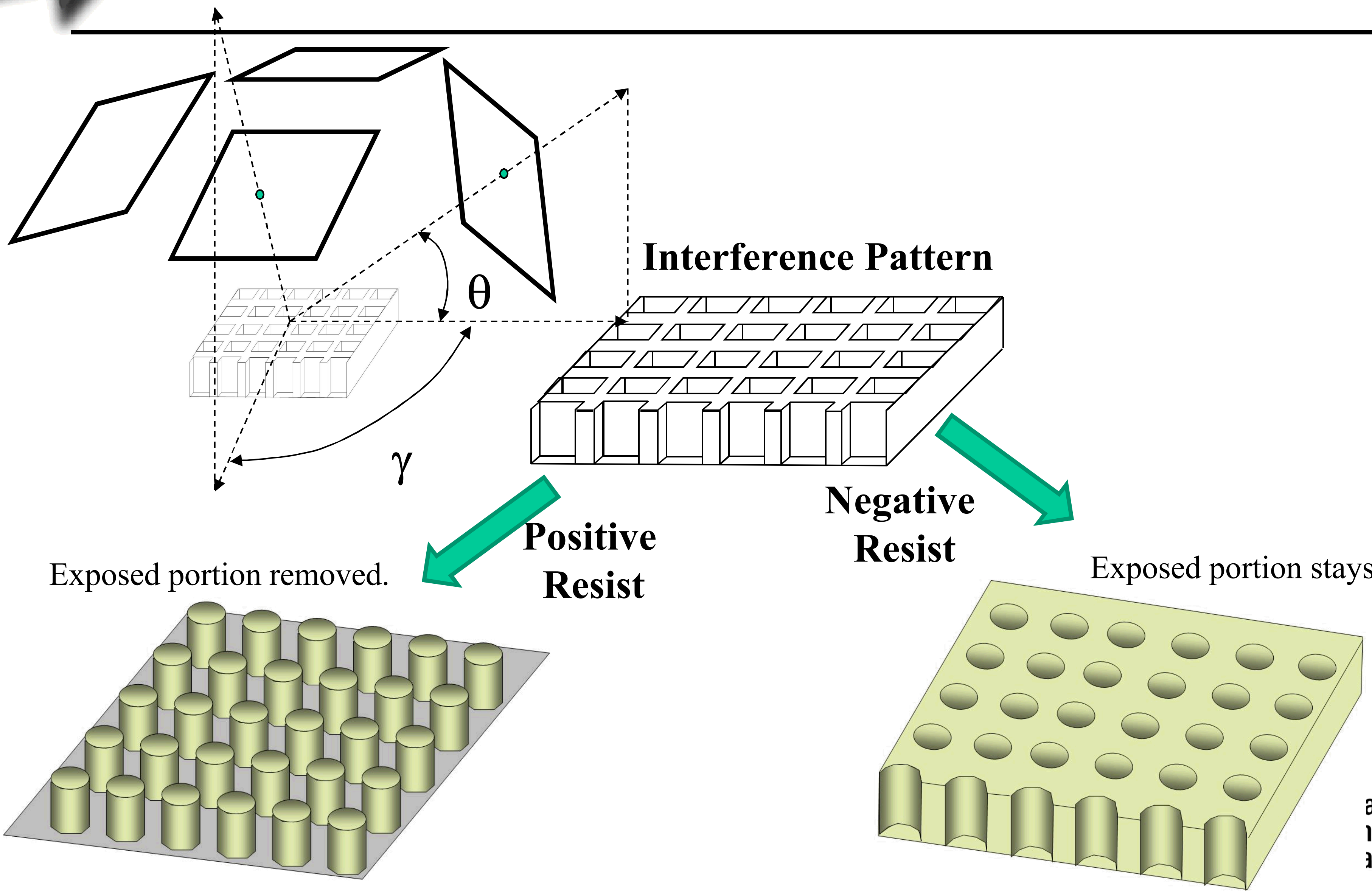
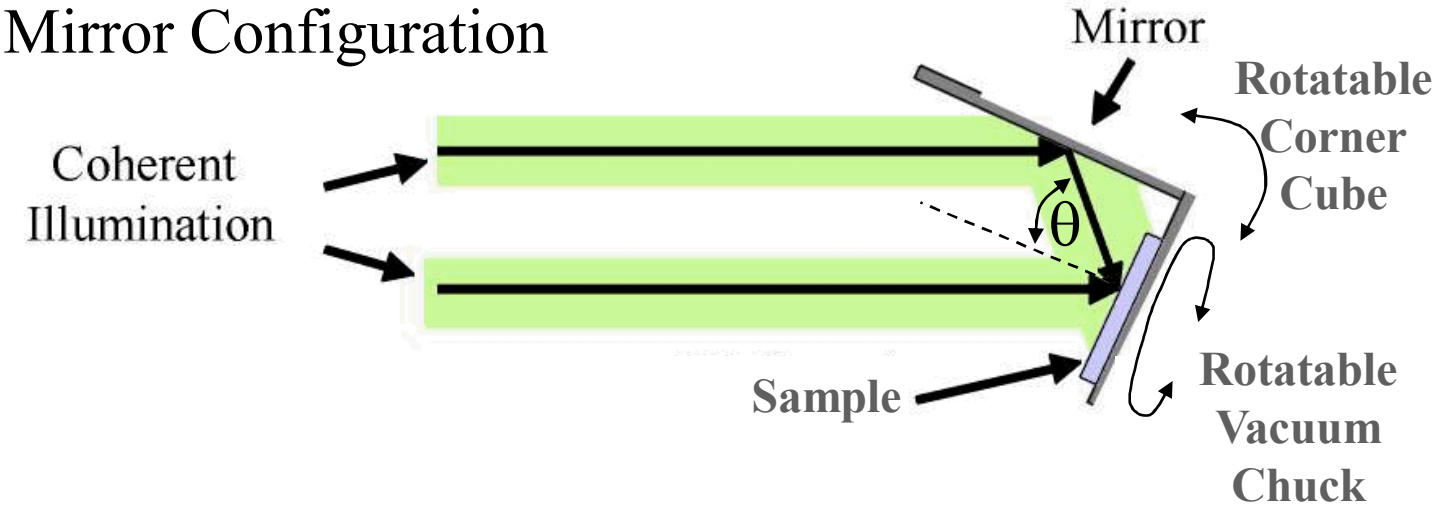
Interferometric Lithography

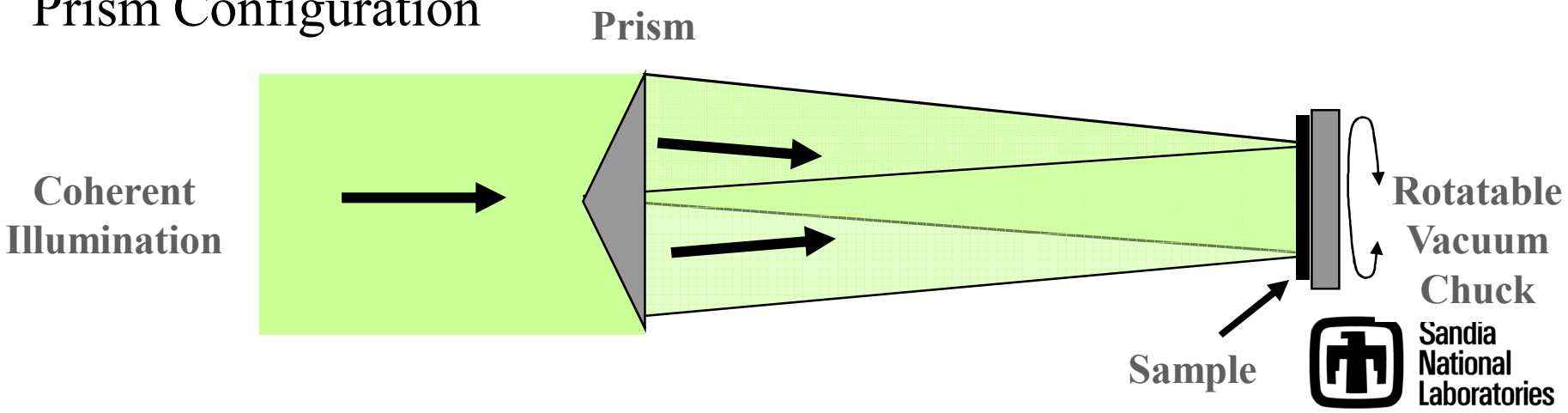


IL Exposure Geometries

Lloyd Mirror Configuration

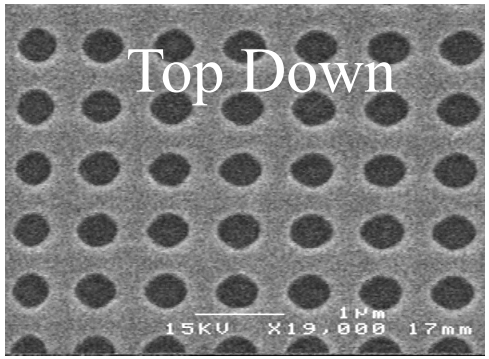


Prism Configuration

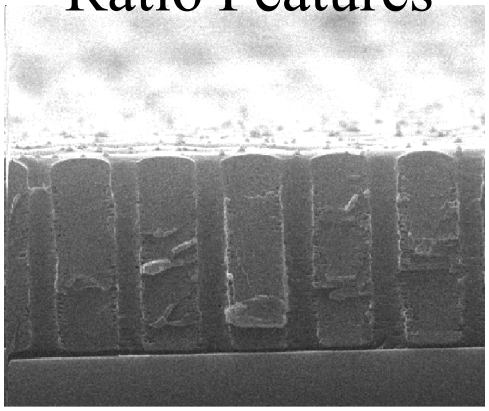


2D and 3D Resist Structures

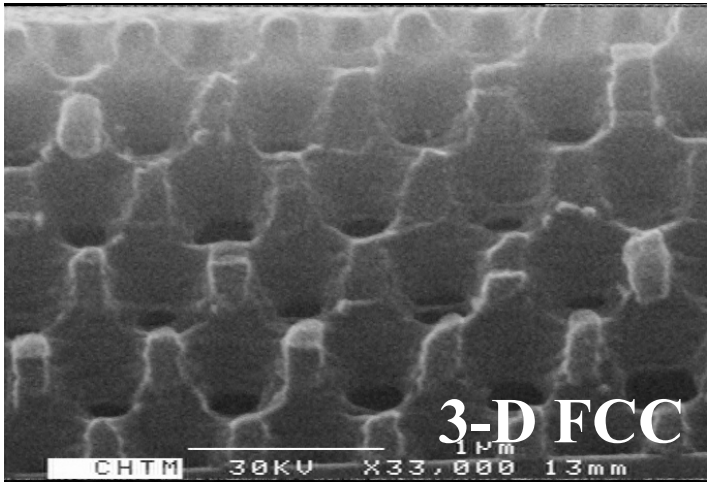
Sub-Micrometer Features

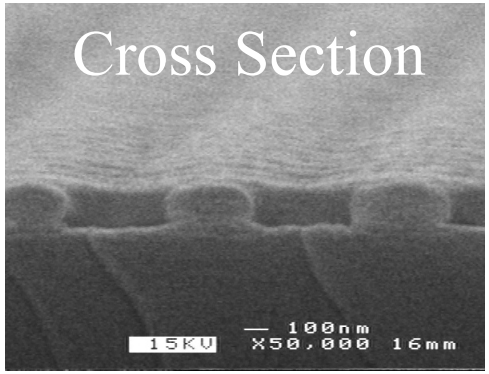


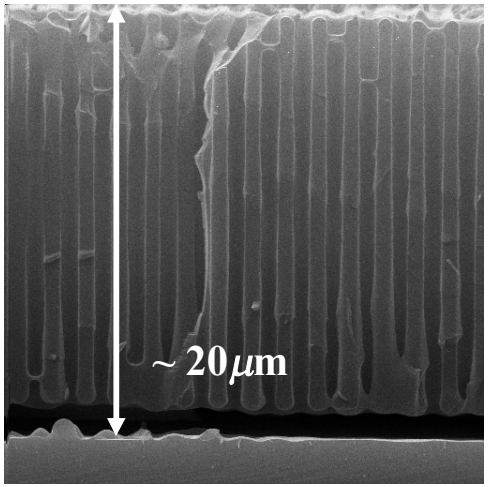
High Aspect Ratio Features

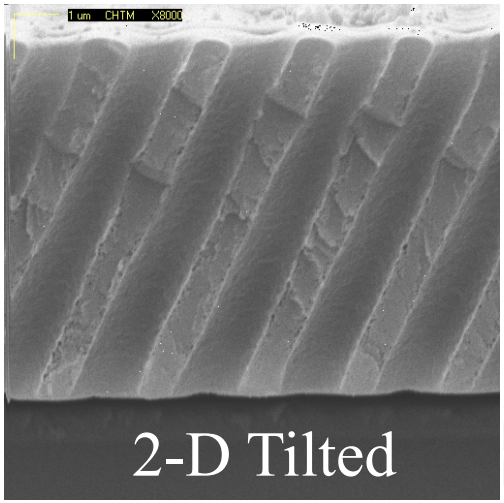


Complex 3-D Structures









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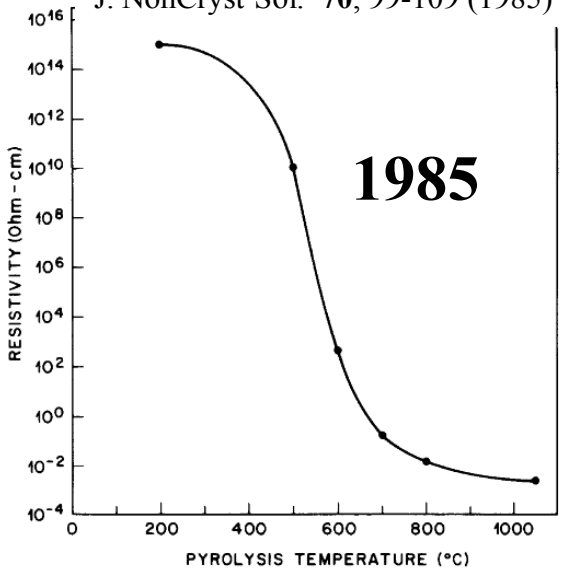
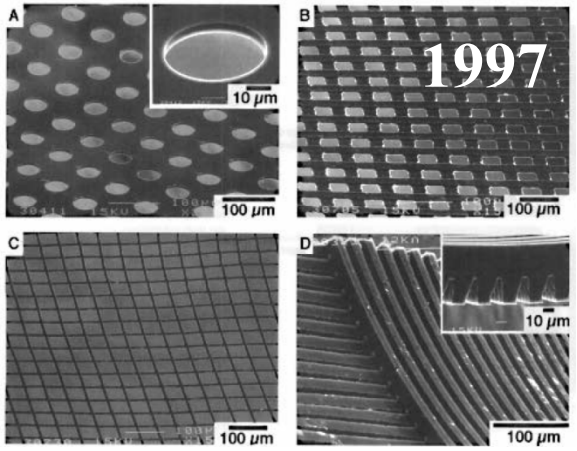
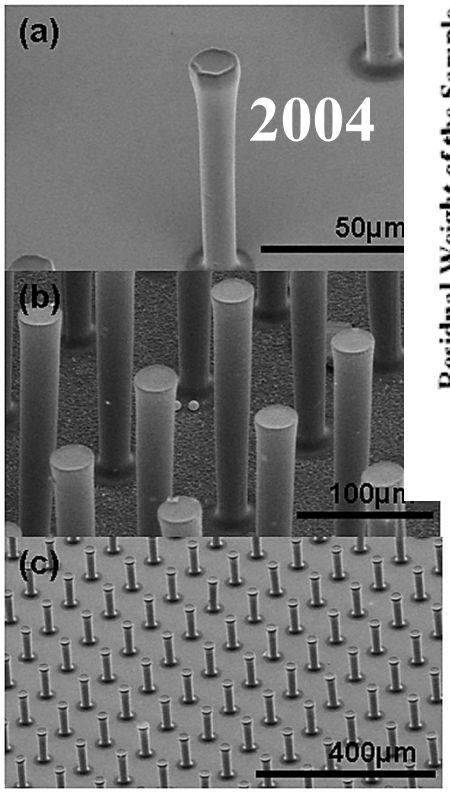
Visual History and Properties of Pyrolyzed Resist

J. NonCryst Sol. **70**, 99-109 (1985)



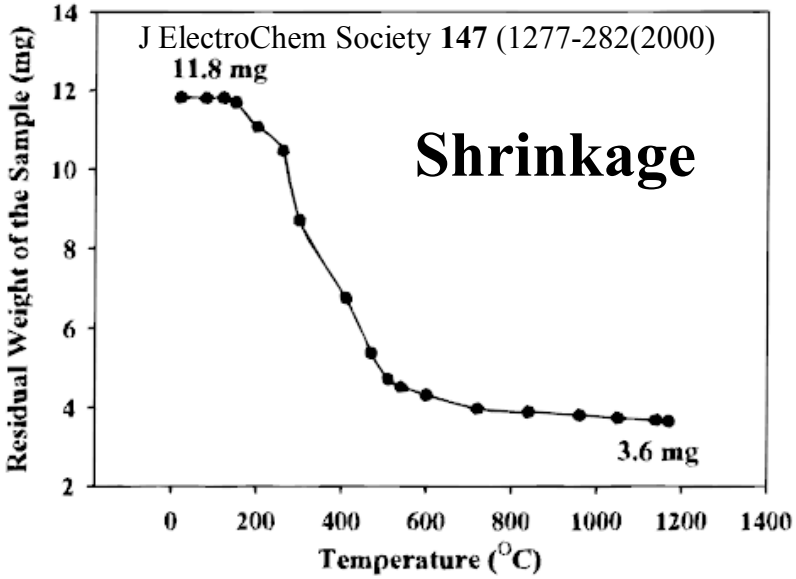


Adv. Mater. **9**, (6) 477-480 (1997)

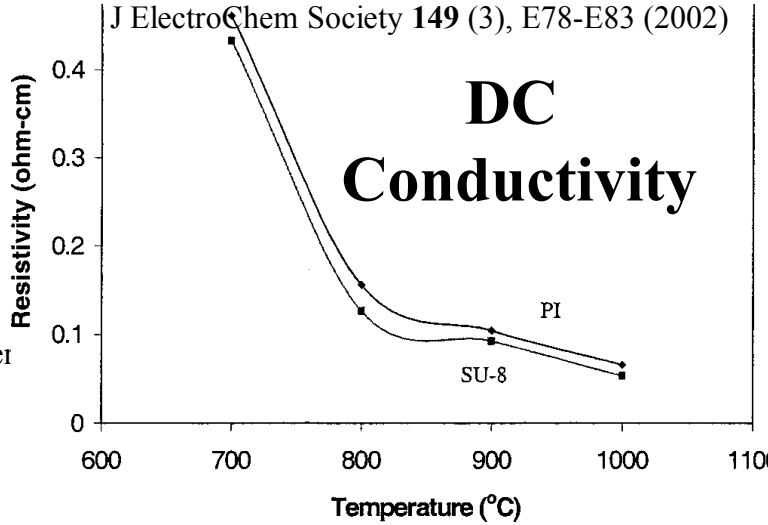


Electrochemical and Solid State Letter **7**, (11) A435-A438 (2004)

J ElectroChem Society **147** (1277-282(2000)



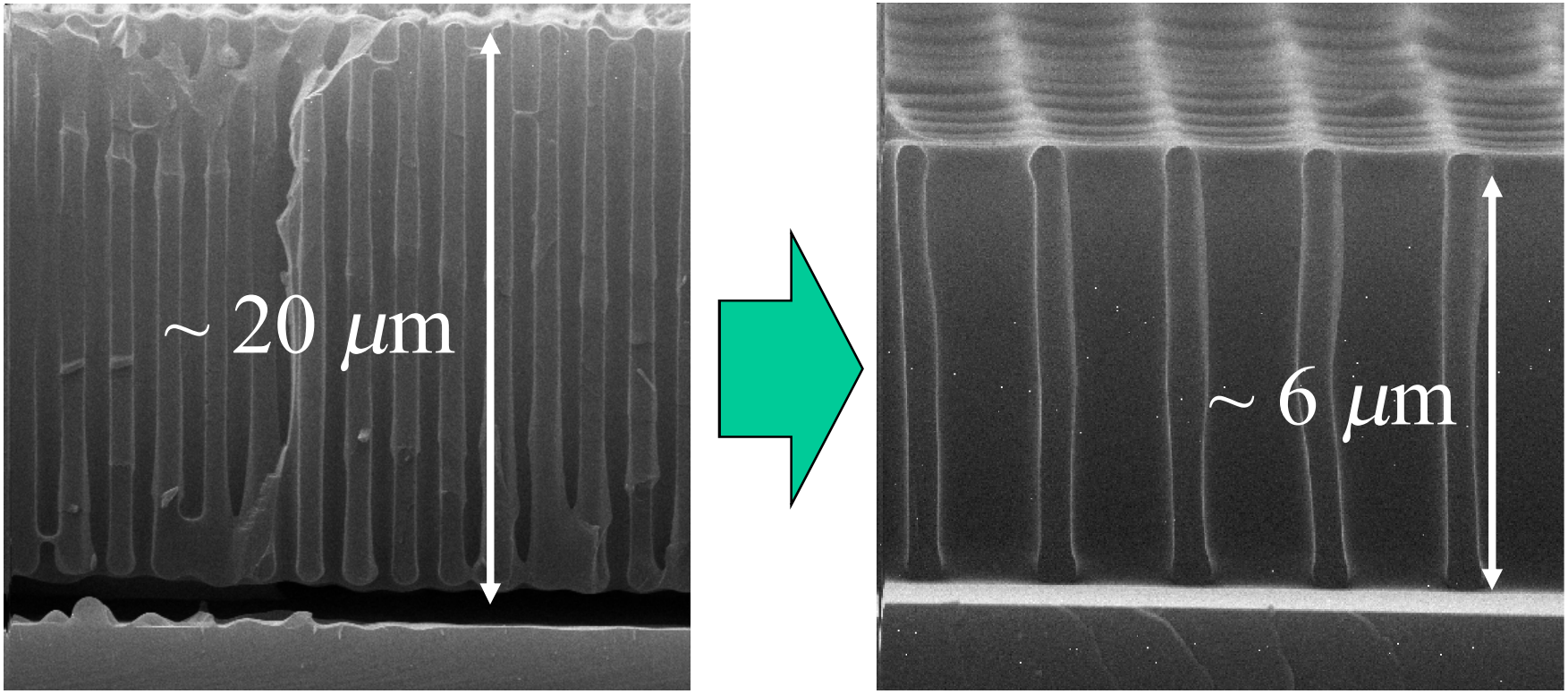
J ElectroChem Society **149** (3), E78-E83 (2002)



Deep 2-D Structures

Resist Structure

Carbon Structure



Pyrolysis @
800 C
under forming gas

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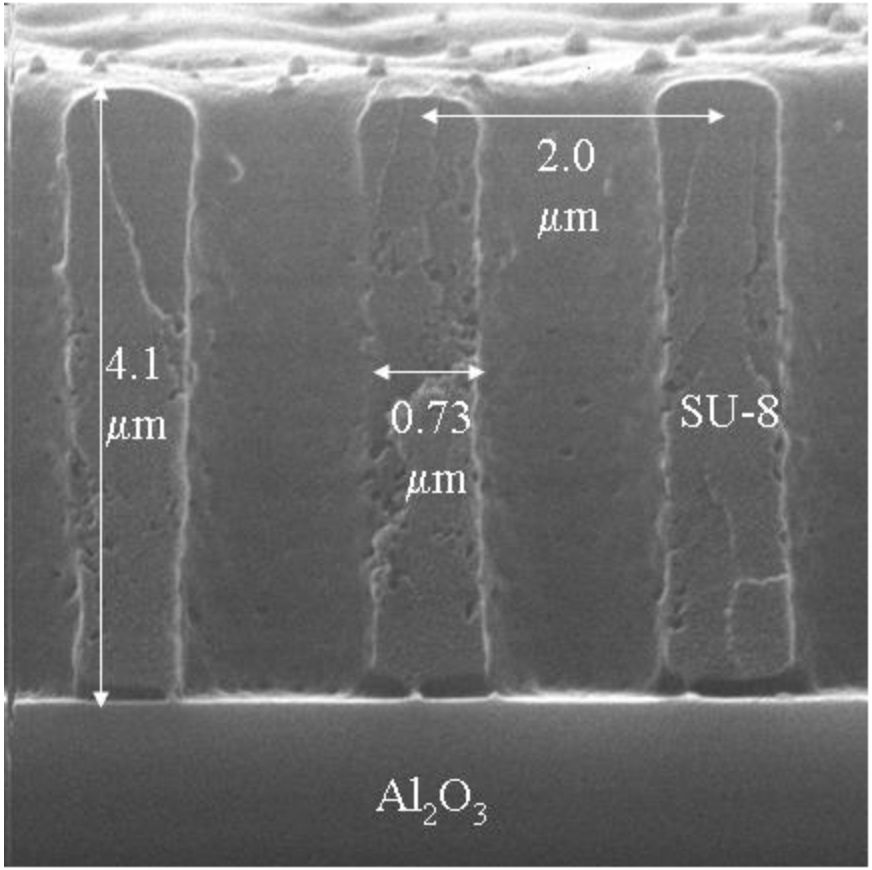
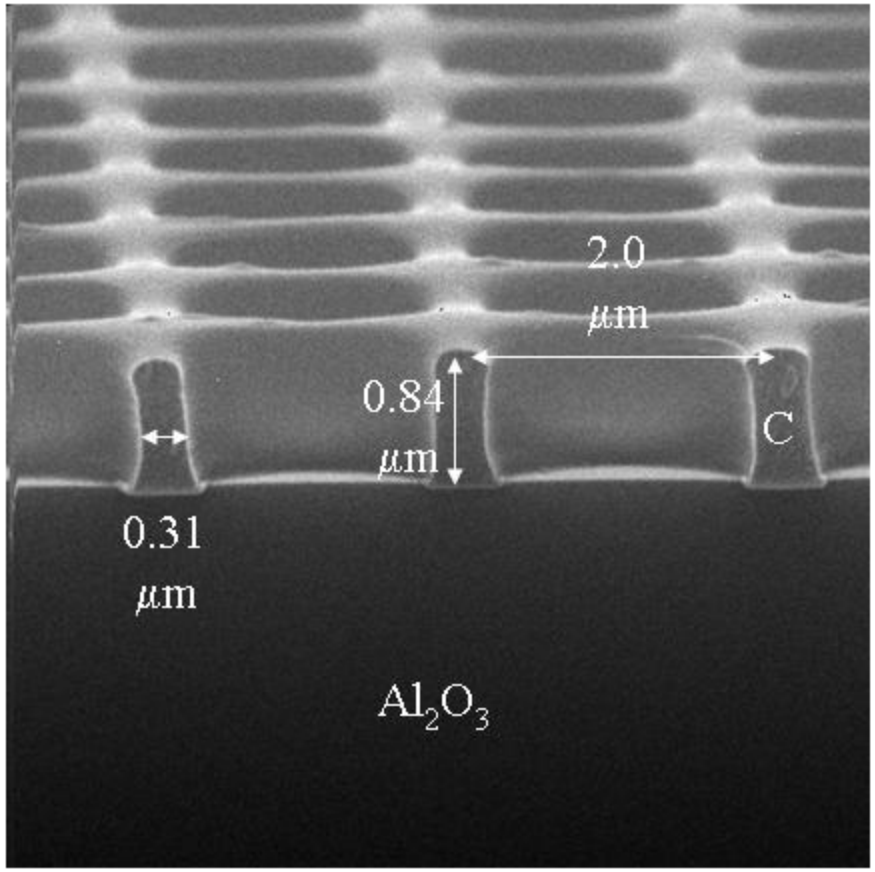
MOCVD GaN Growth Mask





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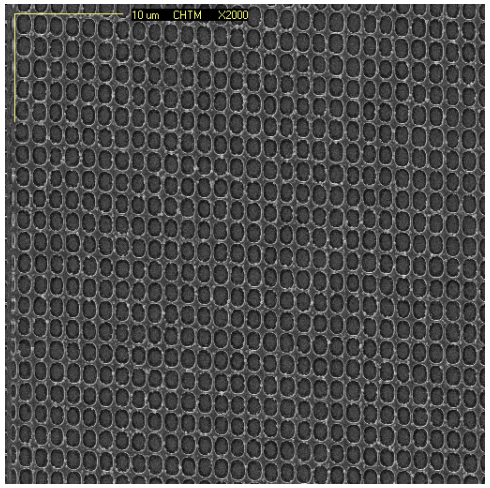
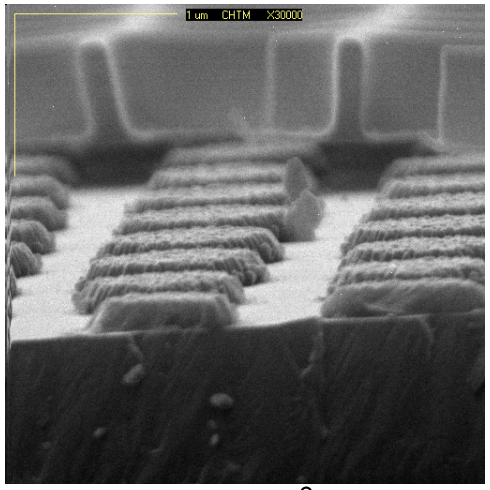
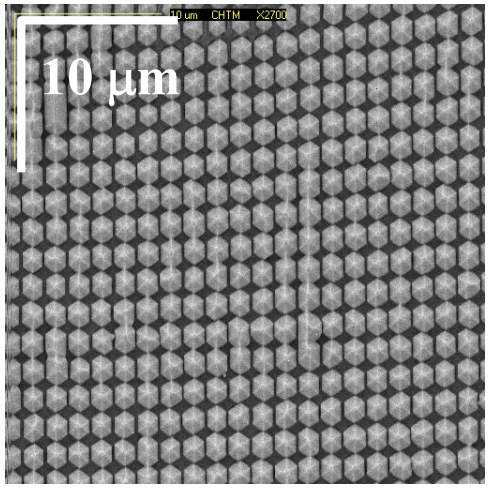
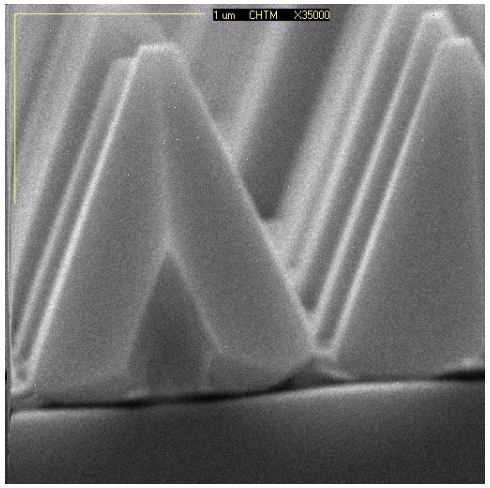
High Temperature Regrowth
1000 Å Nucleation Layer

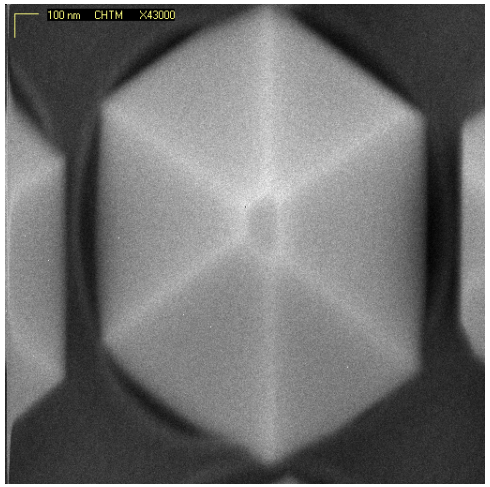


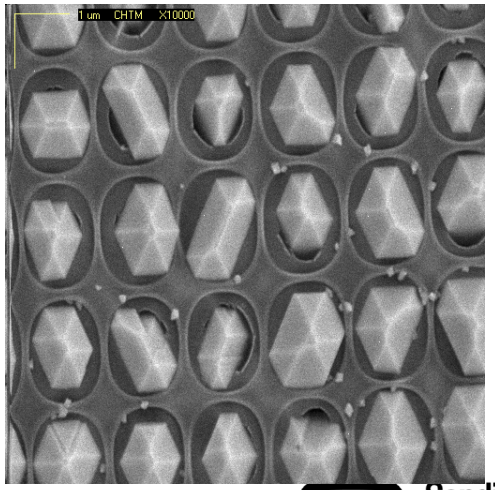


1000 Å
Nucleation Layer









High Temperature
Growth Run

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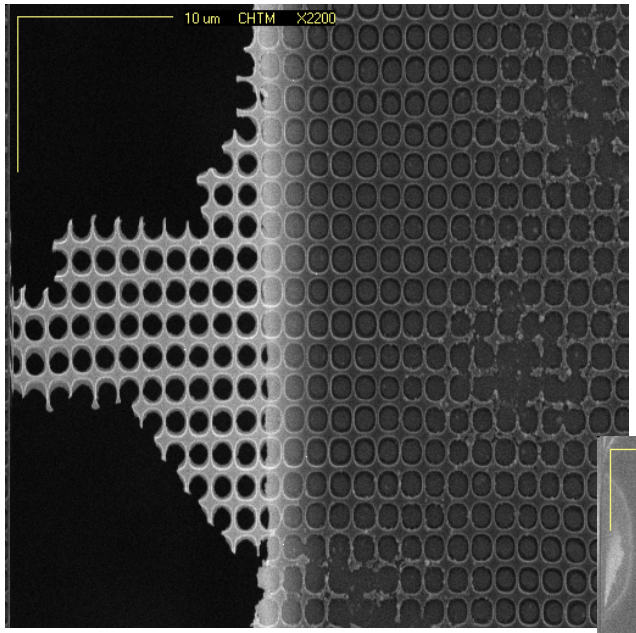
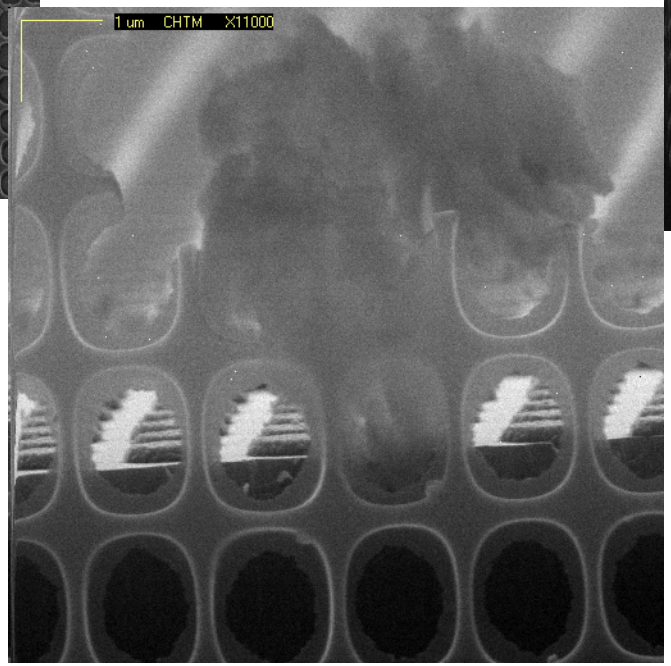
How Rugged is the Template Carbonized to 1200 C?





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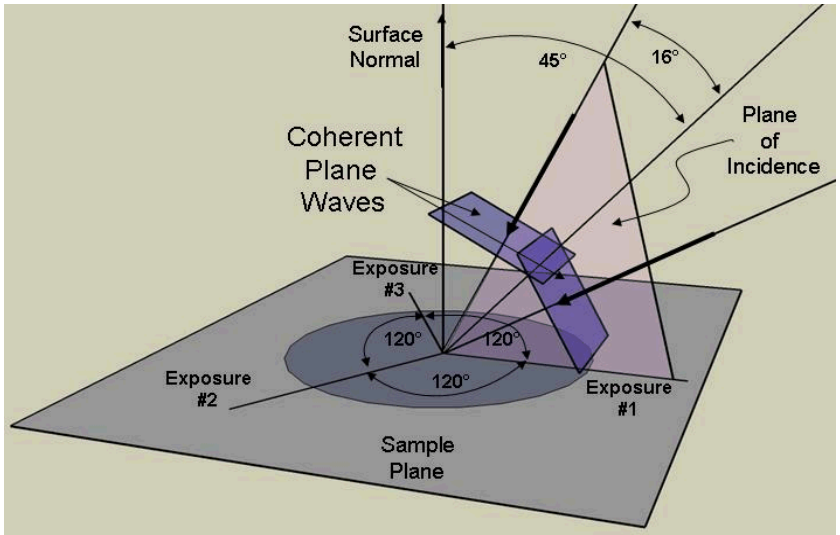
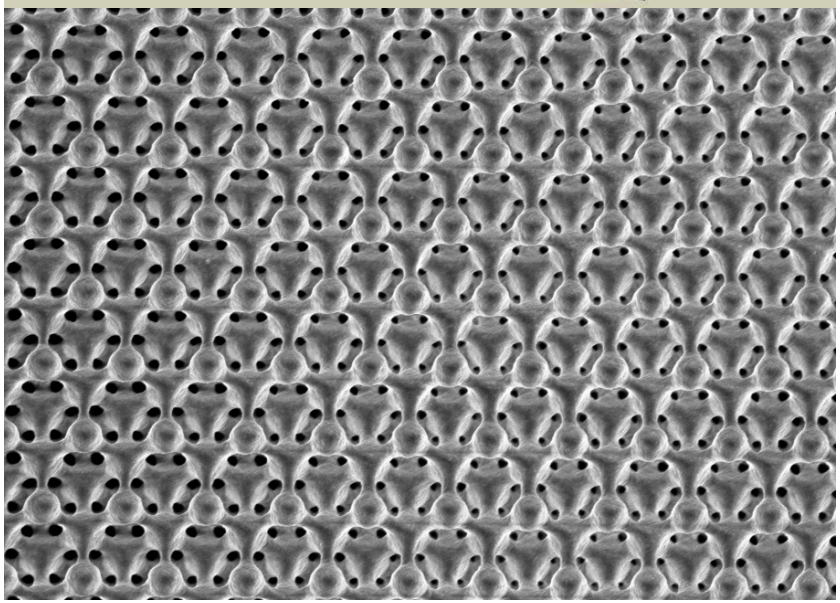
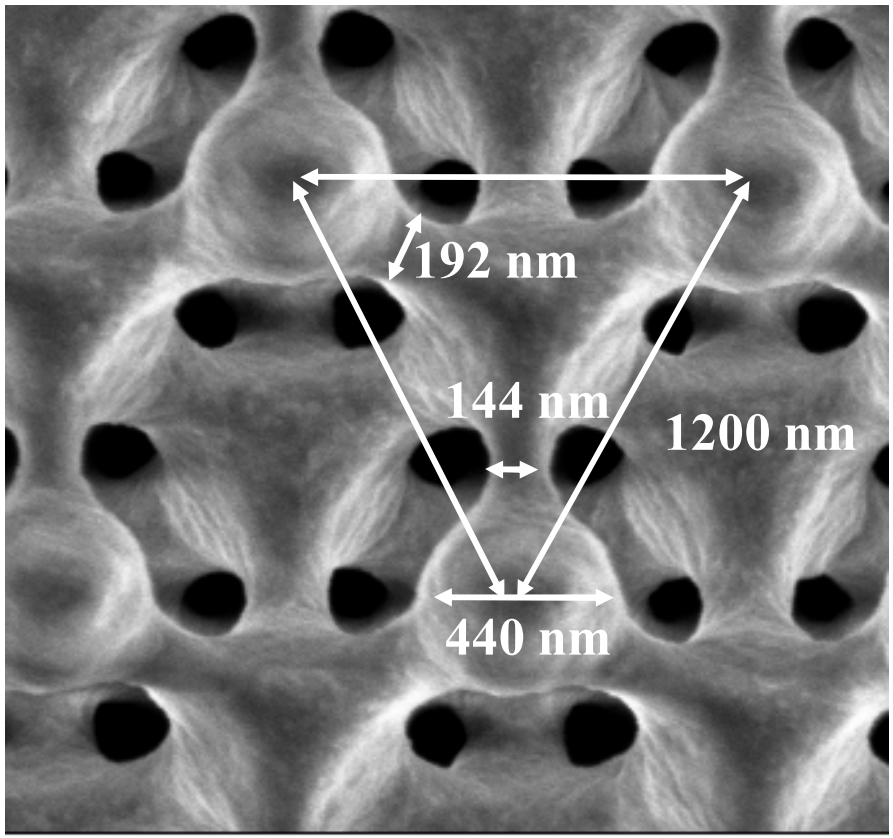
3D FCC Resist Patterns







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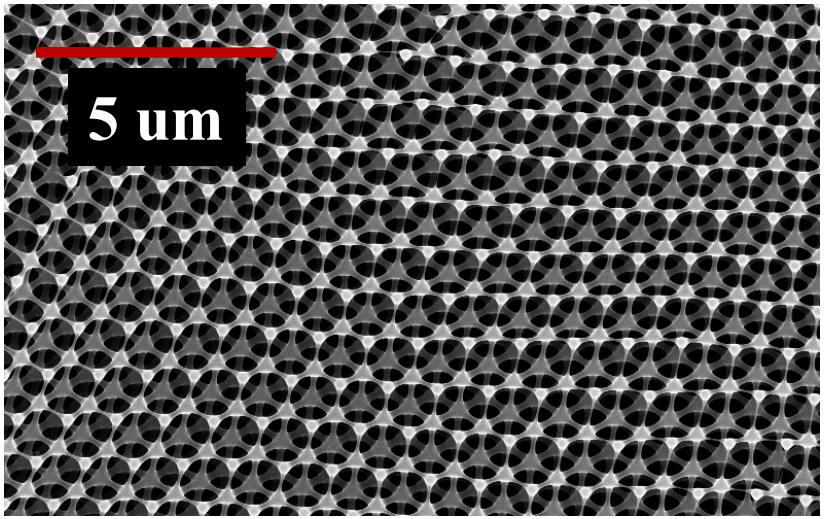
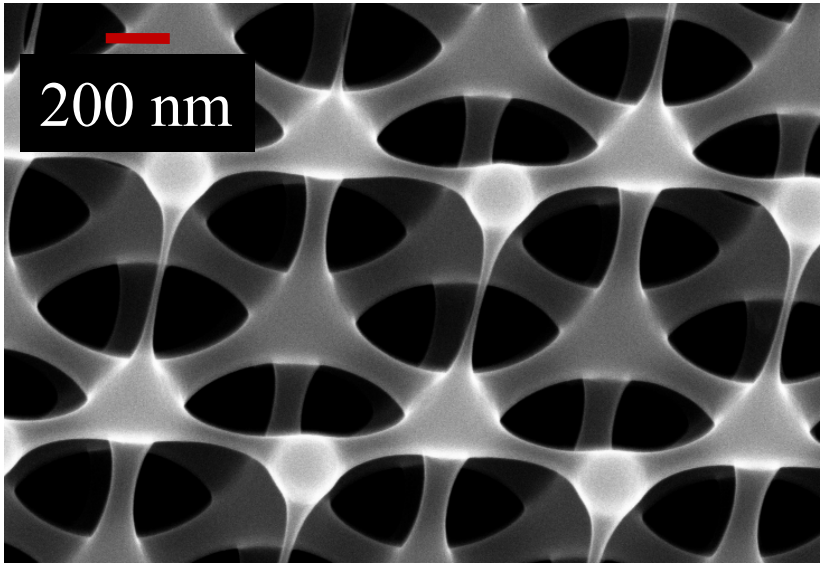
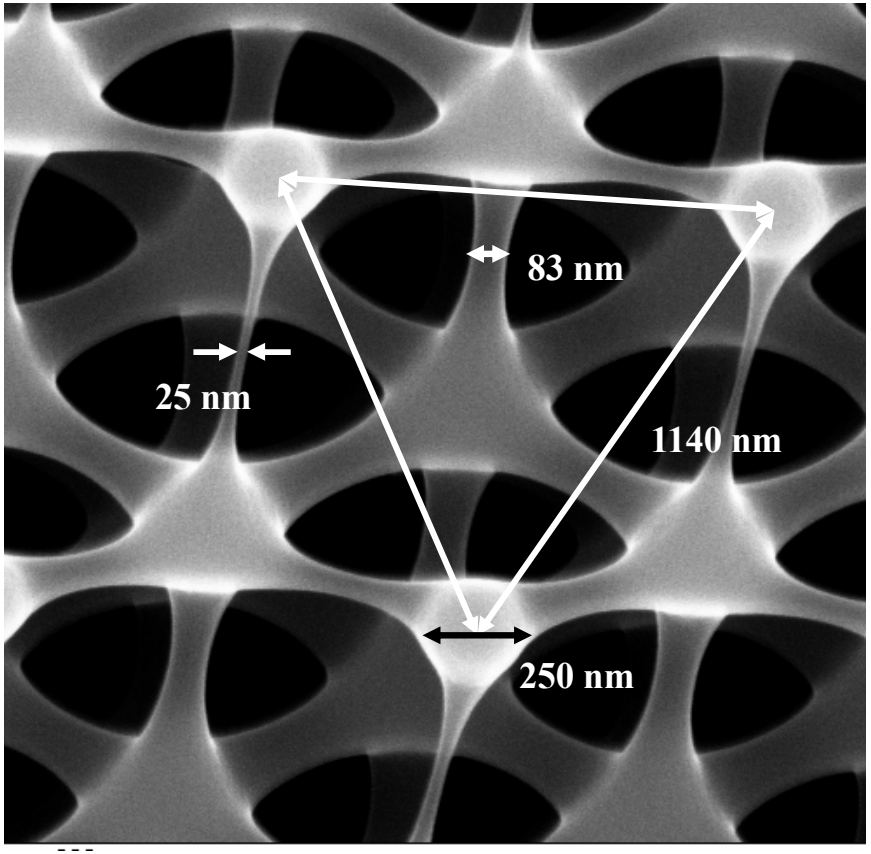
Pyrolyzed Carbon Matrix







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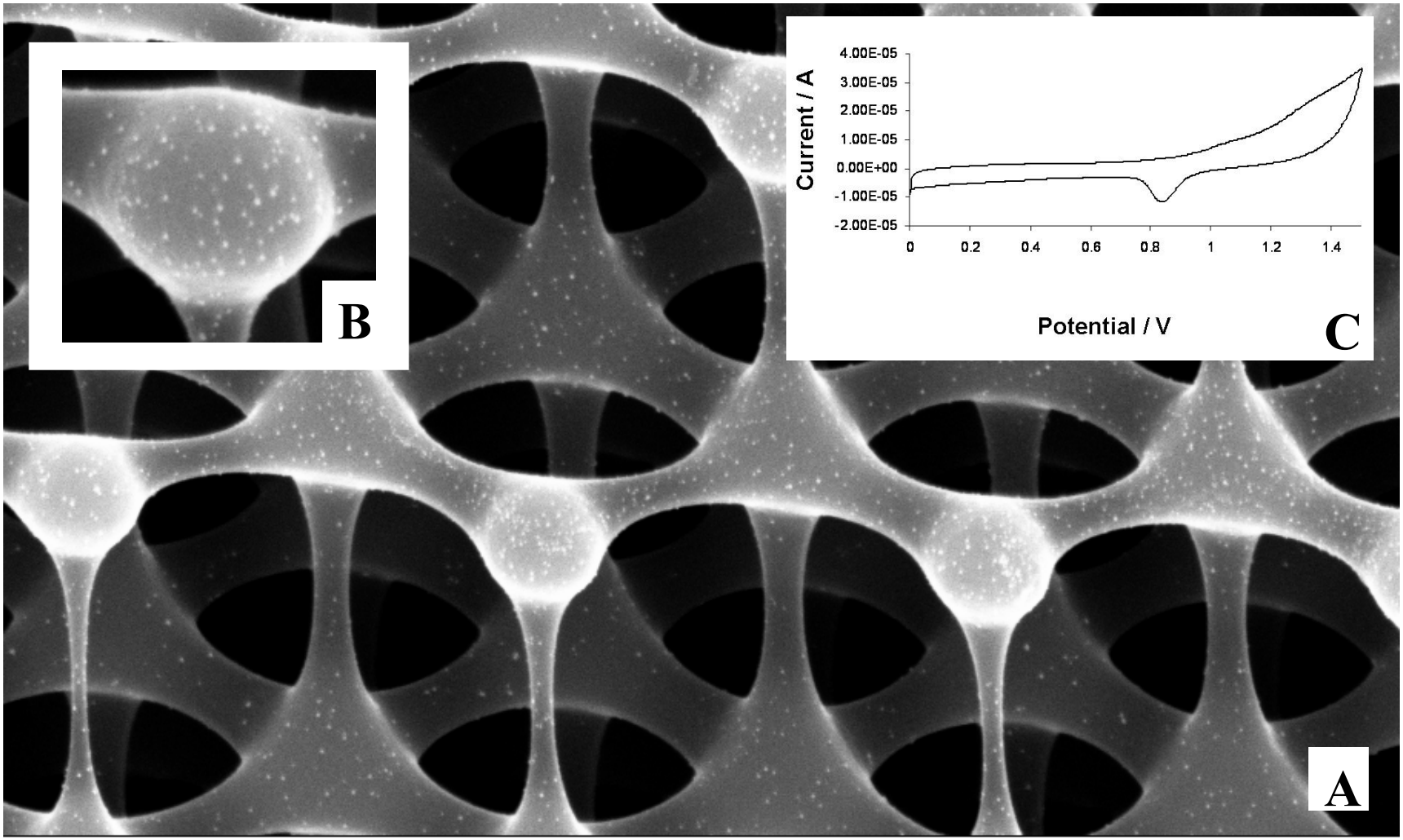
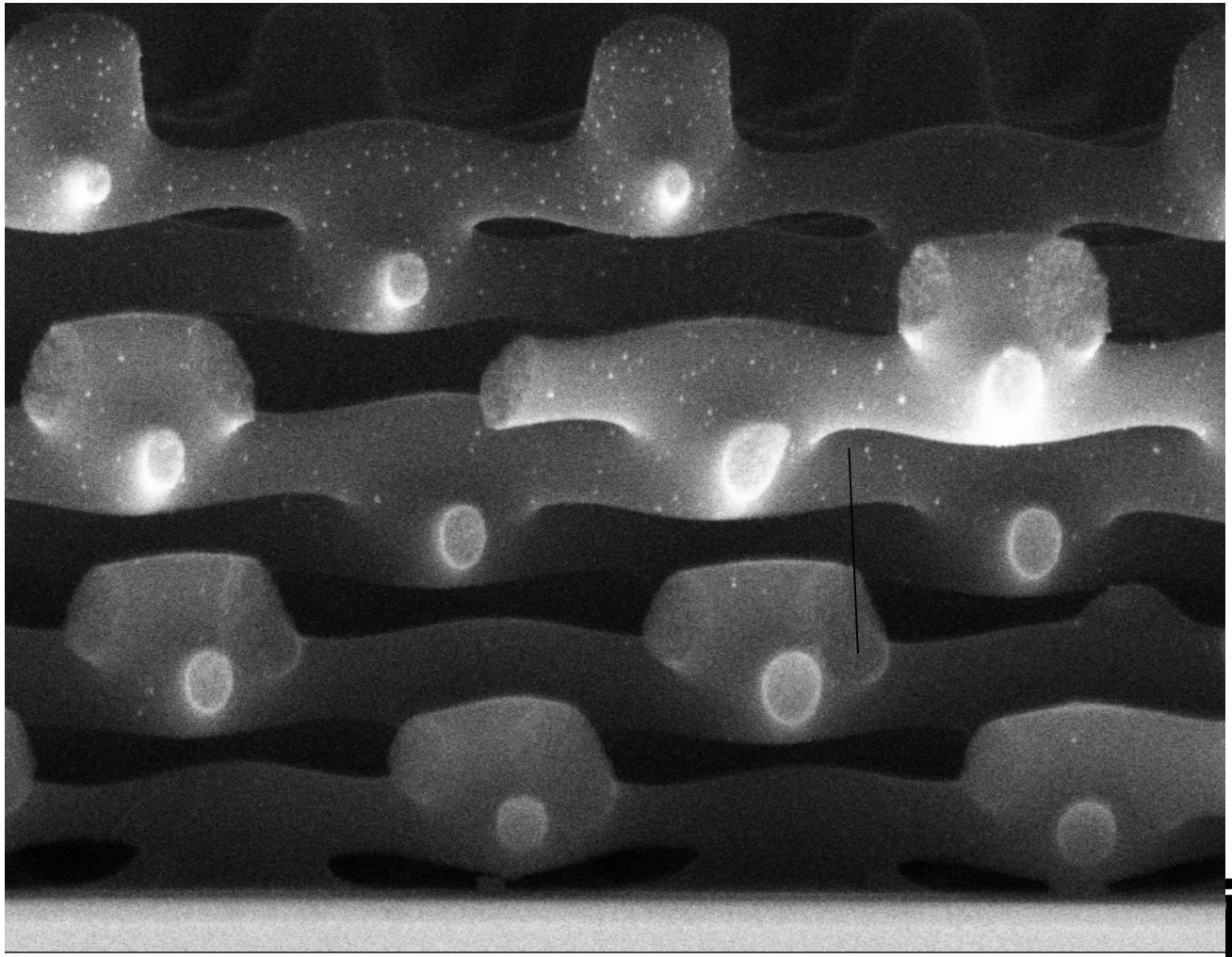
Electrodeposition of Ultra-small Au Nanoparticles



Vertical vs. Horizontal Shrinkage



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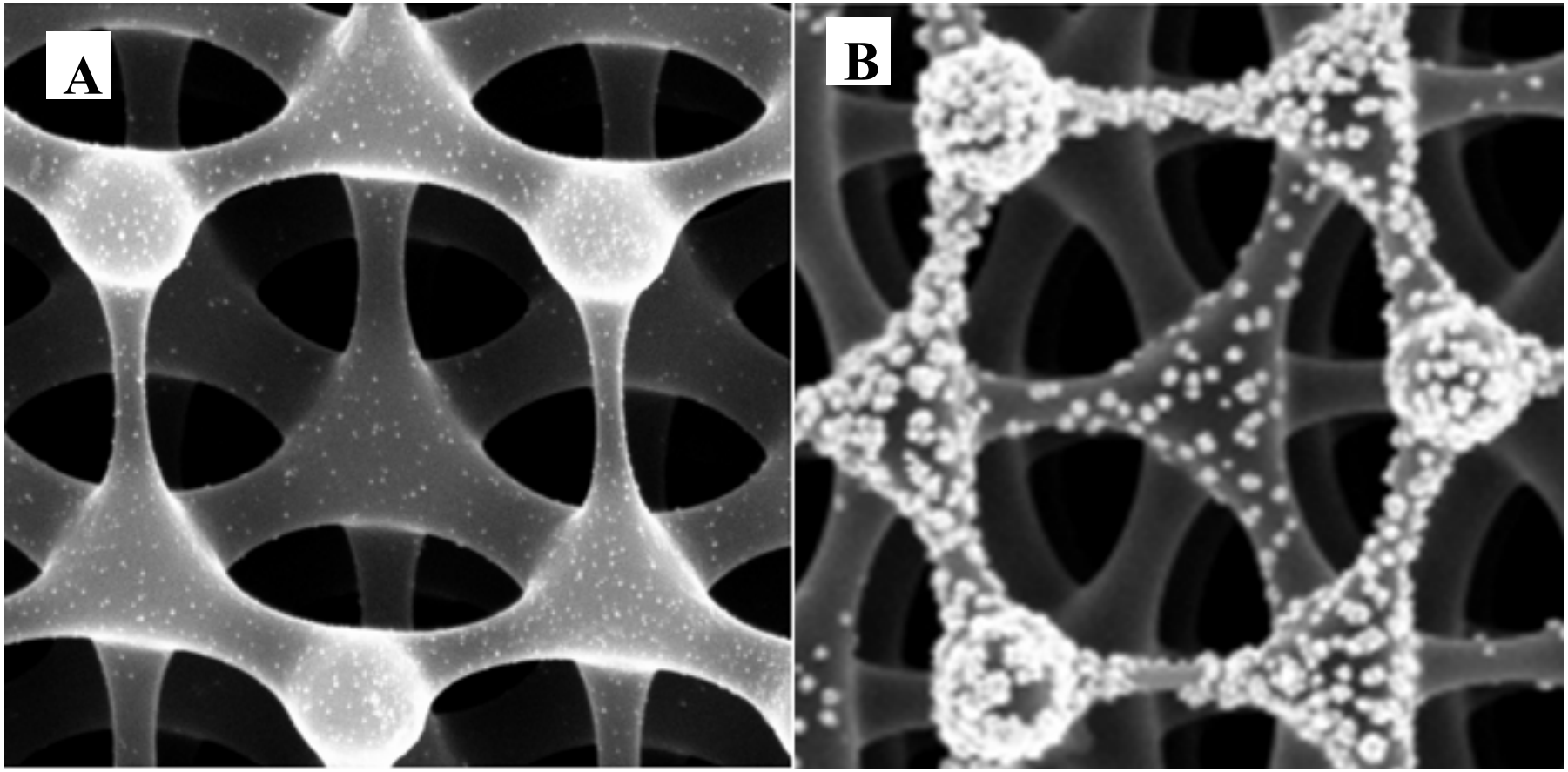
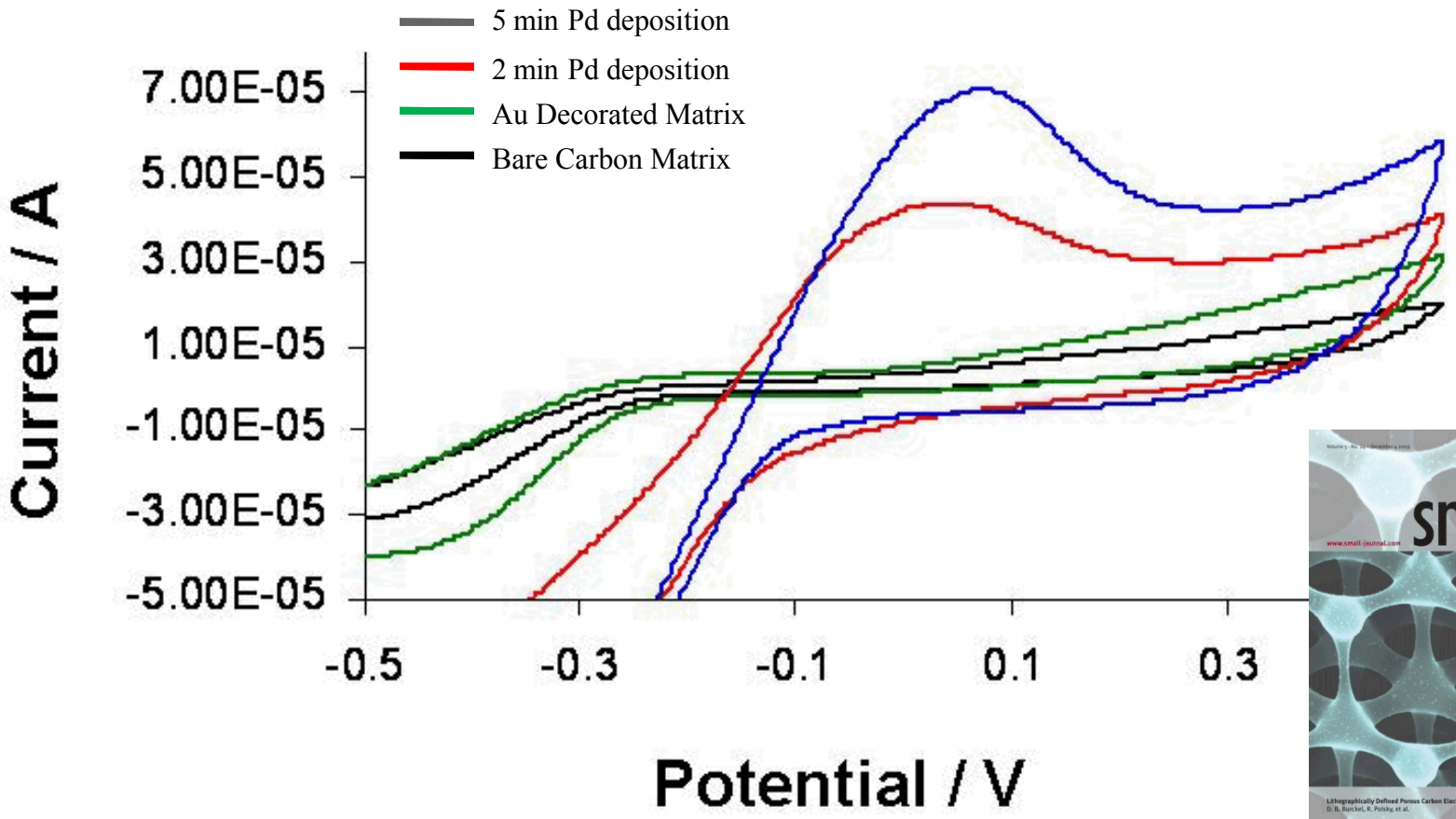
Electroless deposition of Pd Nanoparticles

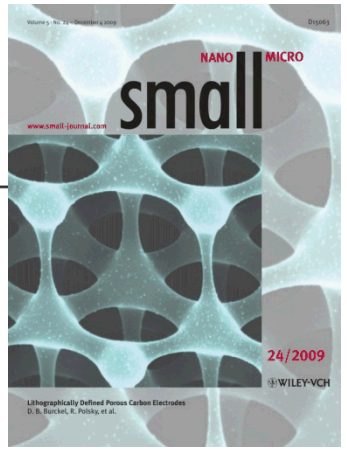


2 min Pd Depostion

5 min Pd Depostion

Application: Fuel Cell





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Conclusions

- Lithographically structured pyrolyzed carbon can perform as an electrochemcial electrode.
- Need to characterize: Actual surface area, electrical homogeneity, and sensitivity to impurities.

Collaborators: (GaN Growth) Hongyou Fan, Dan Koleske
(Fuel Cell work) Ronen Polsky, Cody Washburn, Susan Brozik, and Dave Wheeler – SNL,
Alex K. Raub and Steve Brueck – UNM