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Control of both particle and pore size in nanoporous Pd powders

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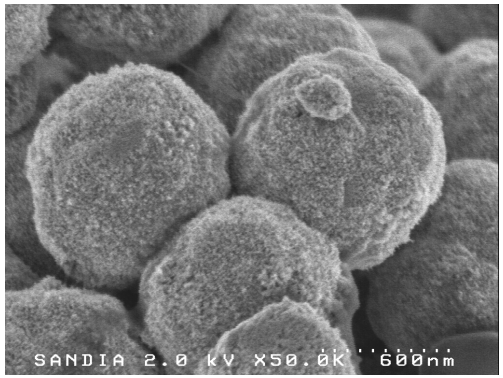

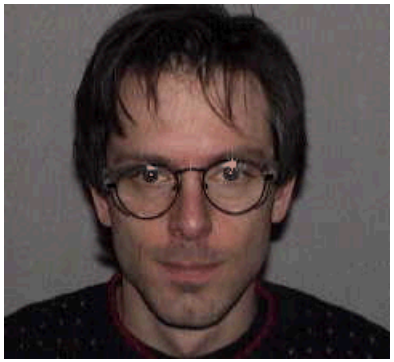

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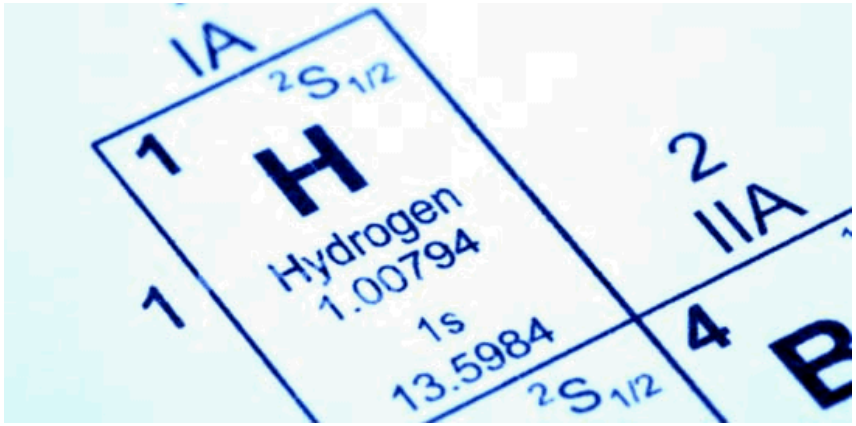
- Purpose
- Why Palladium
- Controlling Porosity
- Controlling Particle Shape/Size



www.askipedia.com/wp-content/uploads/2012/06/hydrogen

www.sciencepicturecompany.com/images/4956/Palladium-Chemical-Element

Hydrogen Storage and Clean Energy

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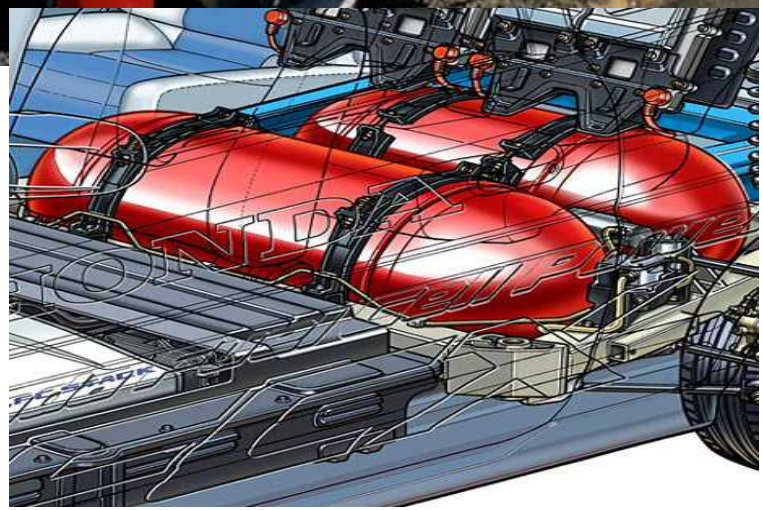
- Hydrogen is clean energy
- Current technology limits use
- Develop safer storage systems
- Improve reliability/efficiency

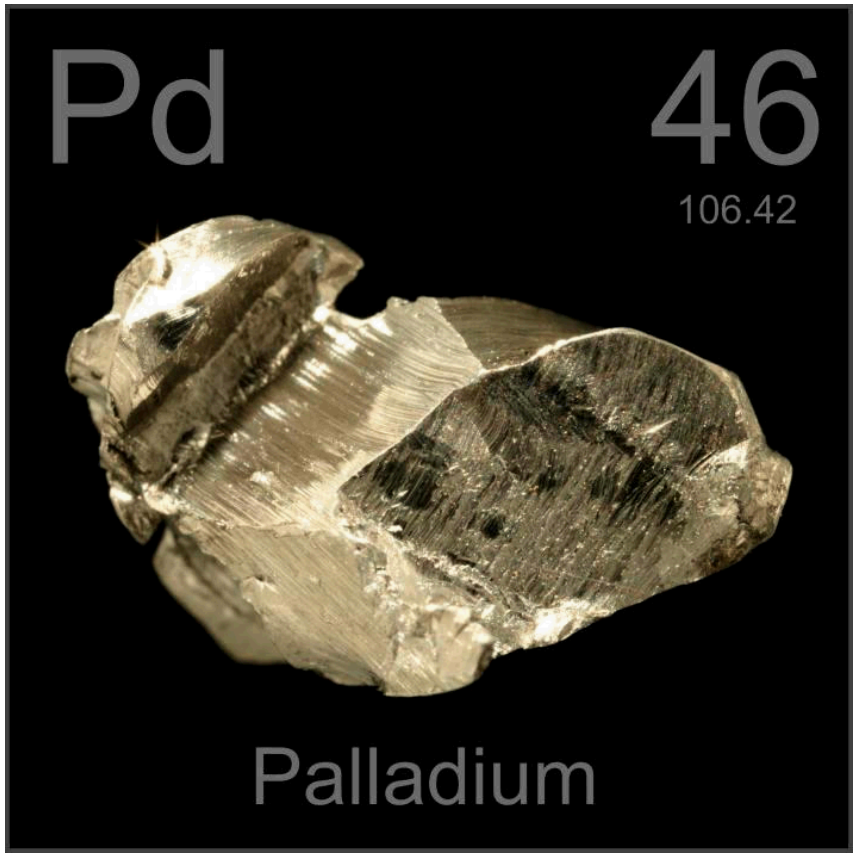
www.sri.com



www.pbs.org/wgbh/nova/sciencenow

Advantages of Palladium

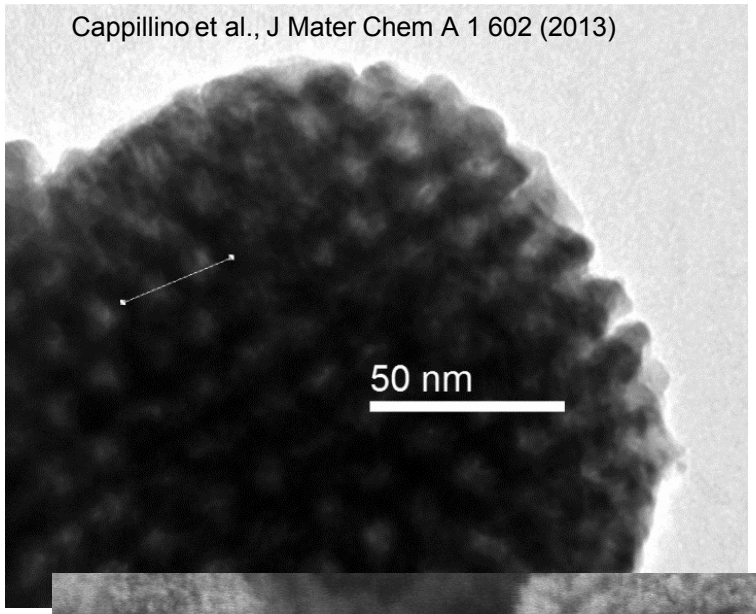
- Similar to Platinum
- Can absorb 900x its volume in Hydrogen
- Absorption rate limited by surface area
- Larger Surface Area = Faster transport rates

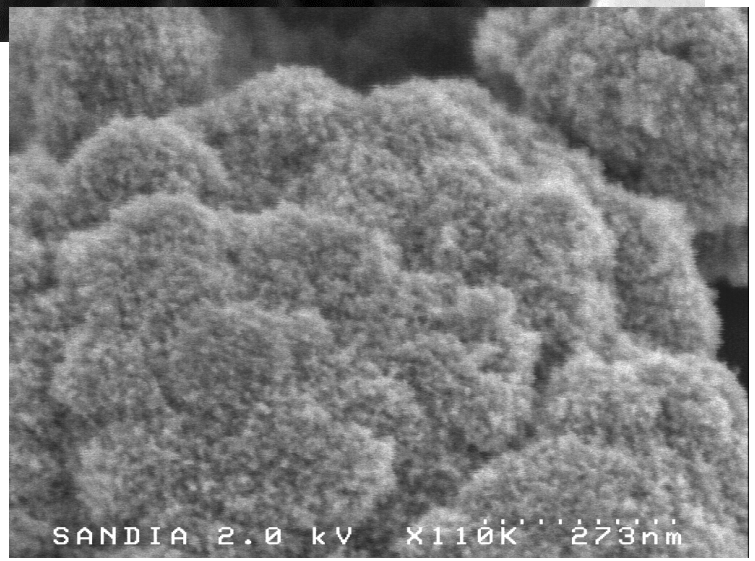


http://periodictable.com/Items/046.10/index.html

Developing Nanoporous Palladium

- Pores maximize surface area
- Pores on nanoscale
- 10 – 20 nm diameter
- Pores = 100 atoms across
- Leads to faster kinetics





Particle size/shape as important as pore size/shape

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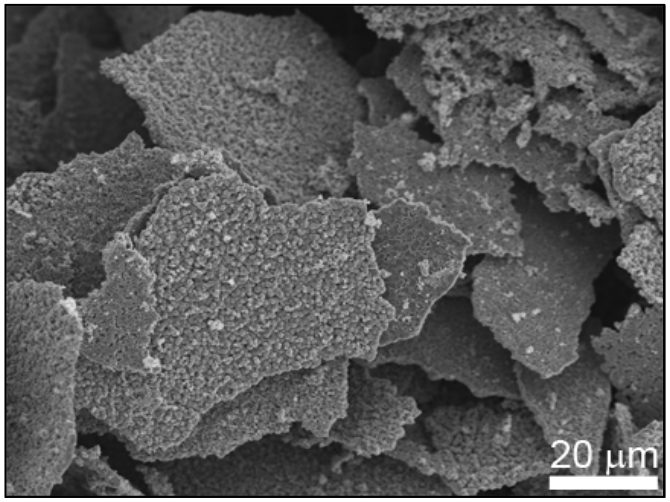
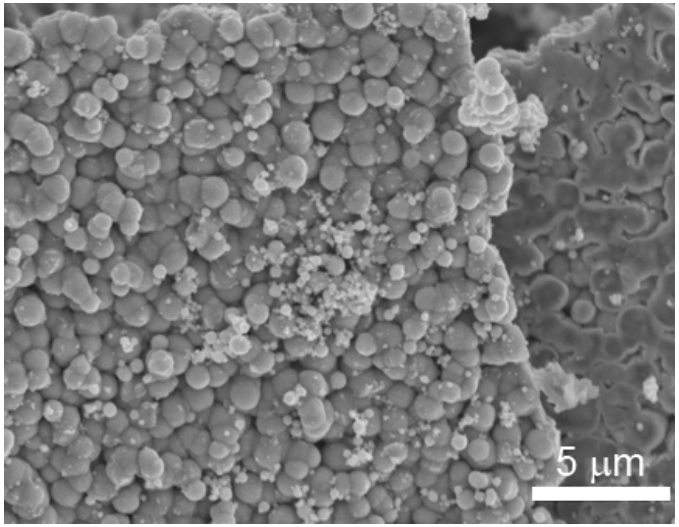
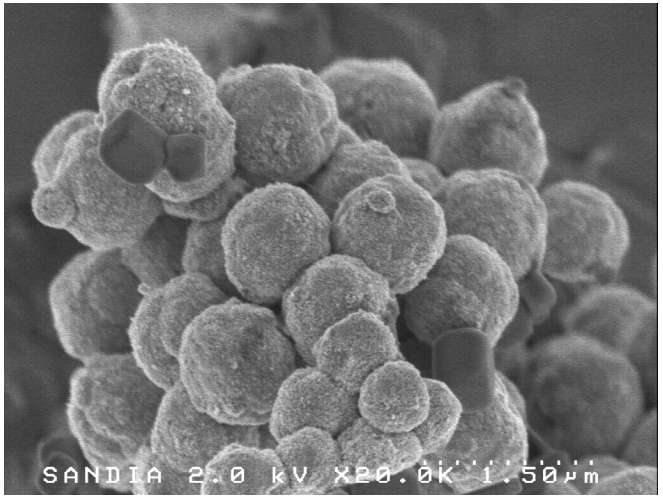
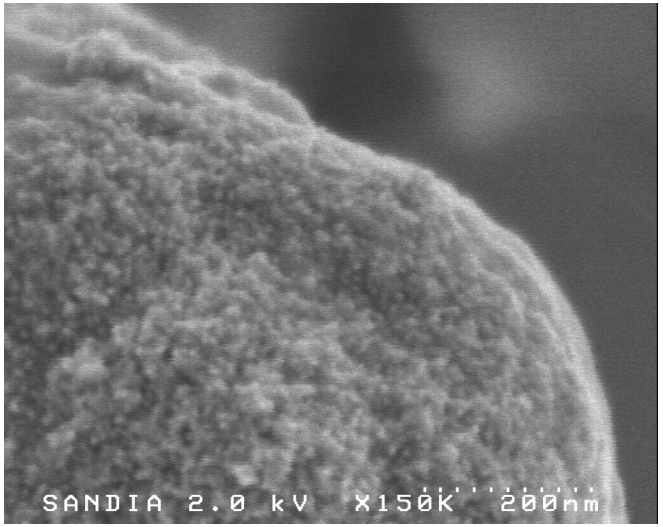
Irregular Particle Size/Shape





Controlled Particle Size/Shape

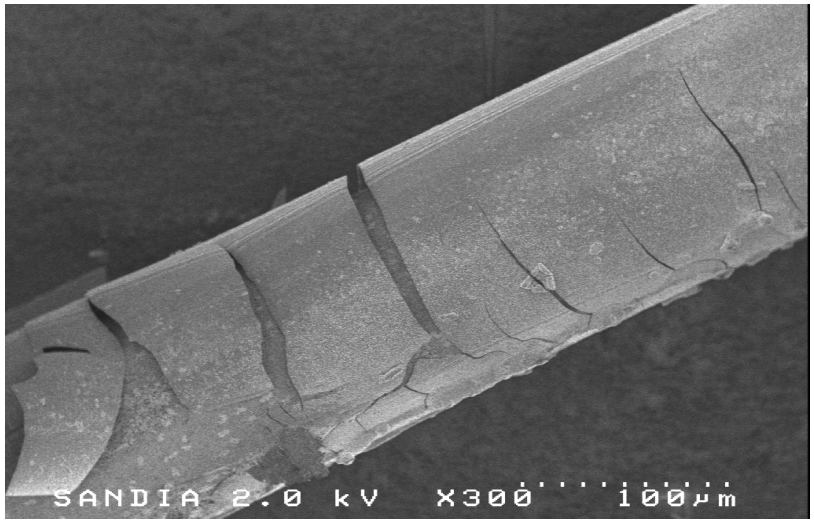


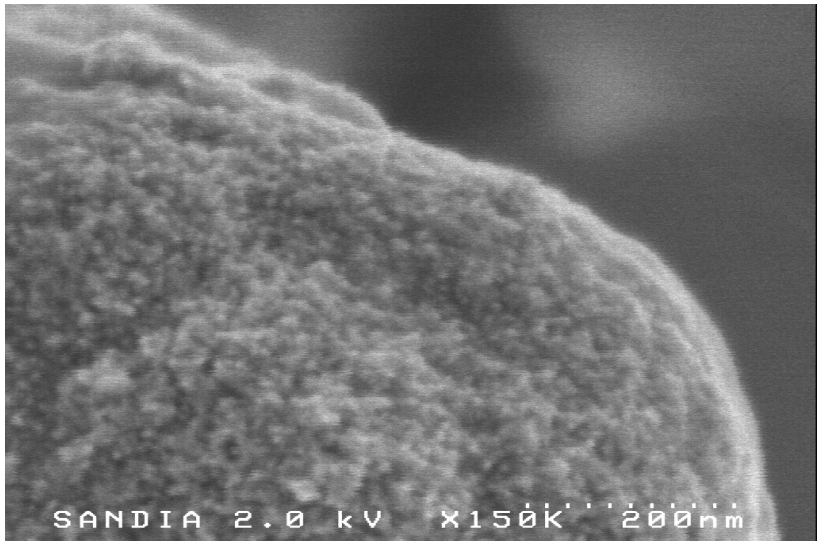


Cappillino et al., J Mater Chem A 1 602 (2013)

Chemical Reduction with Copper

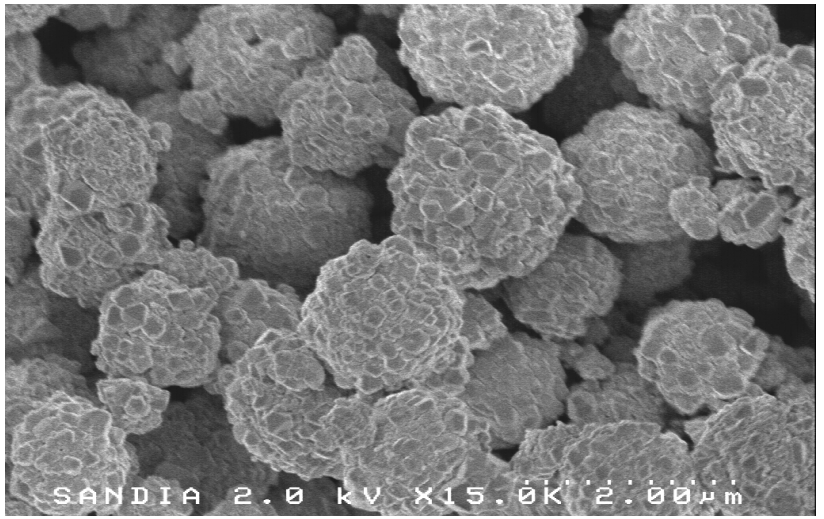
- $Pd^{2+} + Cu^{0} \rightarrow Pd^{0} + Cu^{2+}$
- Pd takes shape of copper
- Surfactant can be added to reaction solution
- Surfactant yields good pore size on surface



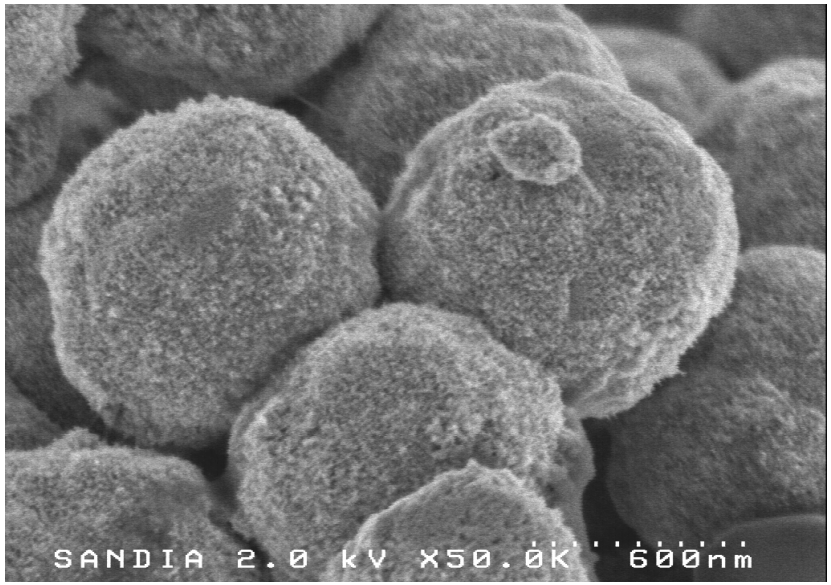


Optimal conditions for Pd-Cu reduction

- 1:1 ratio Cu to Pd
- Cu dispersed in 1.0 wt% Pluronic F127 solution
- Pd salt dissolved in 2M NaCl solution
- Mixed at room temperature/3 - 4 days
- Reaction limited by amount of copper in one particle



Cu



Pd

Summary

- Palladium used for hydrogen absorption
- Controlling pore size maximizes surface area
- Controlling shape improves surface area and packing density
- Possible for future large scale production