3D Integrated Micro and Nano Structures for Ultra-Capacitors

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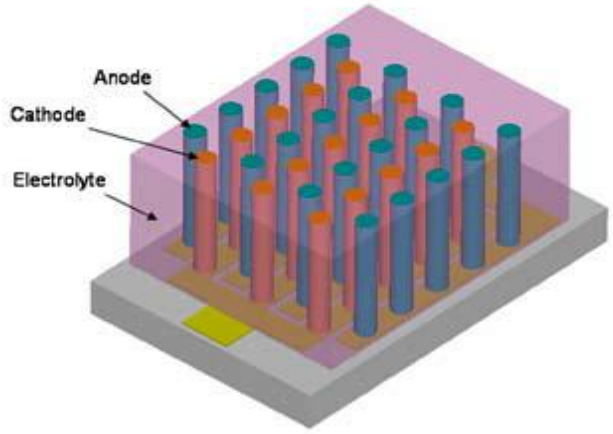
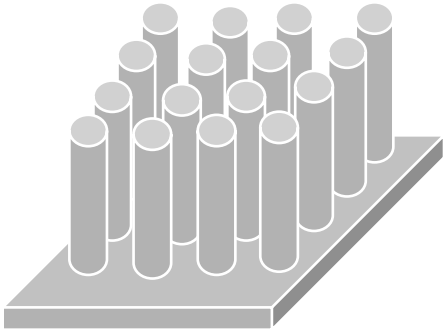
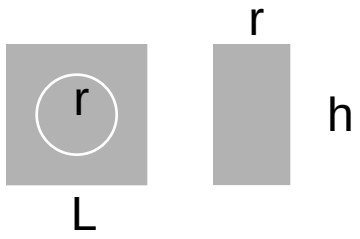
Latest design trend in energy storage devices – going skyscrapers

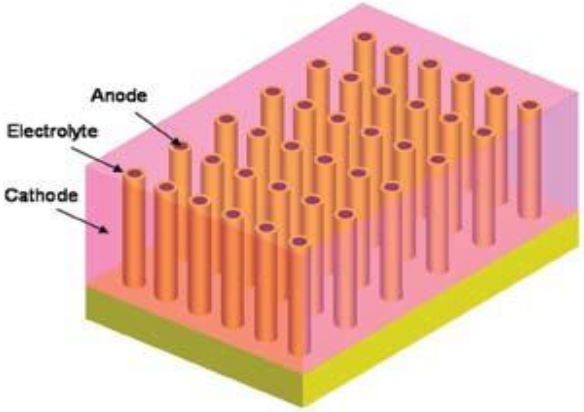






$$p = \pi r^2 / L^2$$

$$S / S_0 = (\pi r^2 + 2\pi r h) / L^2$$



An example:

r = 50 nm

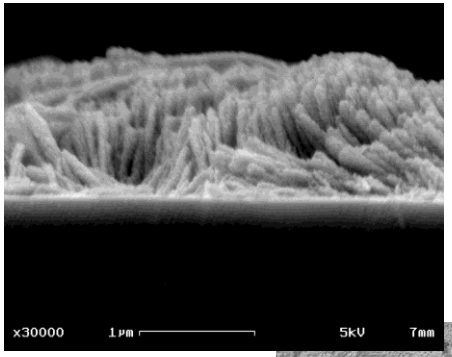
h = 2 μm

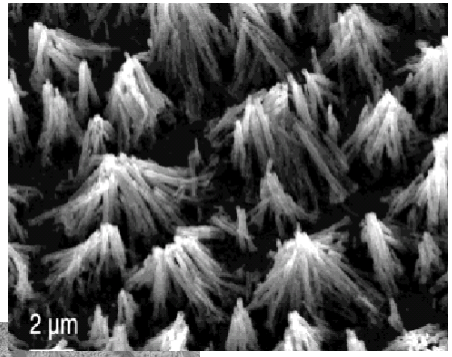
p = 25%

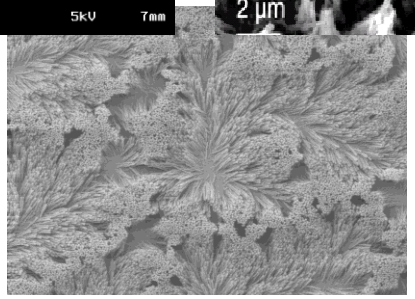
$$S / S_0 = (\pi r^2 + 2\pi r h) / L^2$$

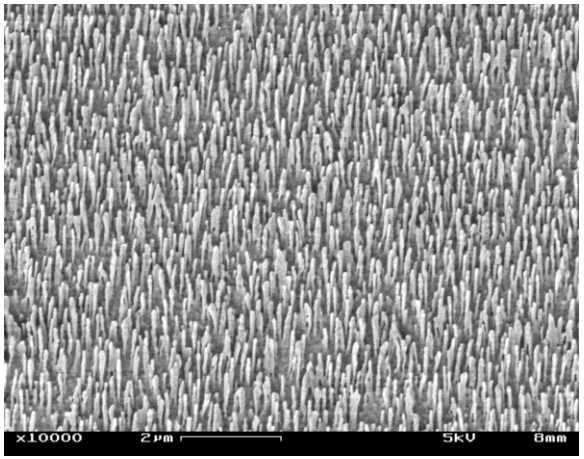
$$= (1 + \frac{2h}{r}) p = 20.25$$

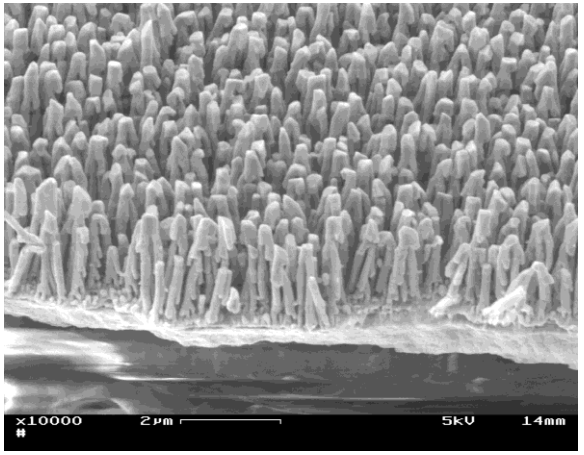
Problems with skyscraper nano structures

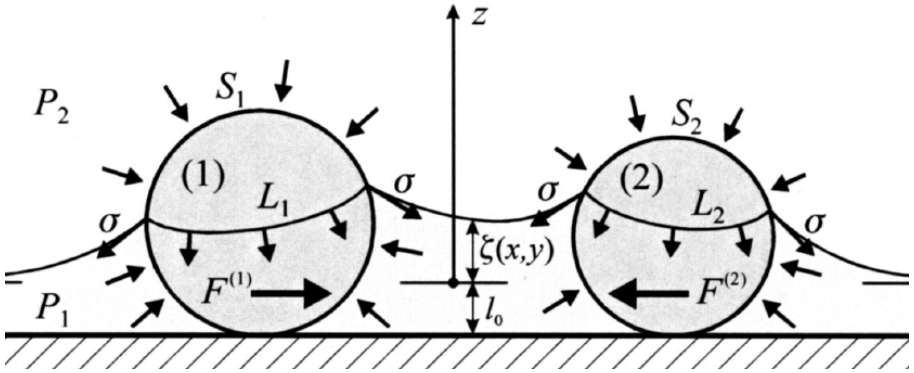




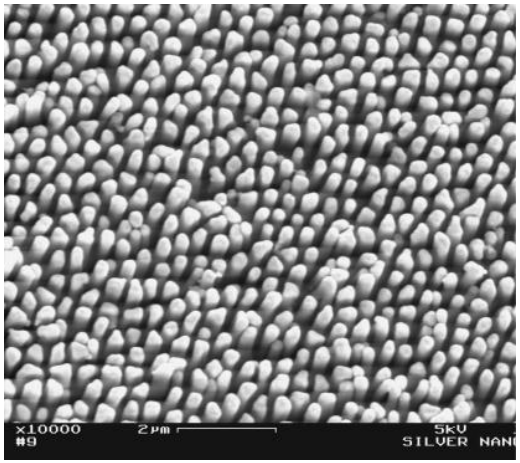


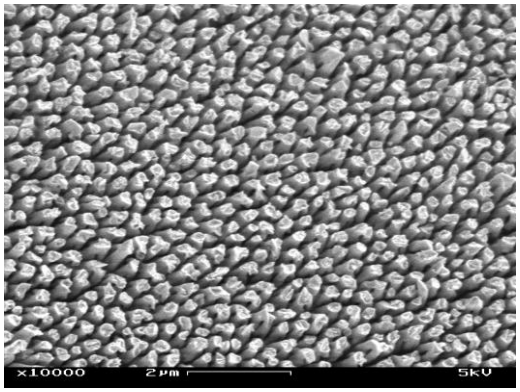


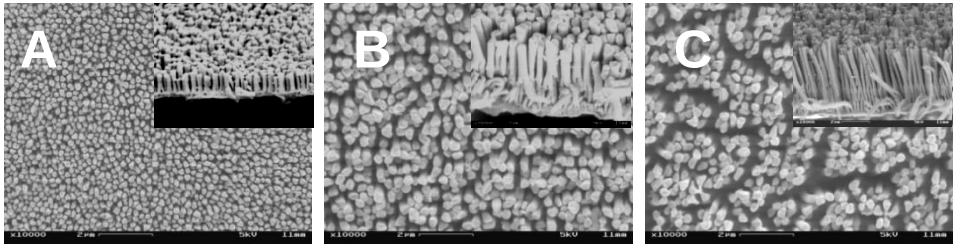


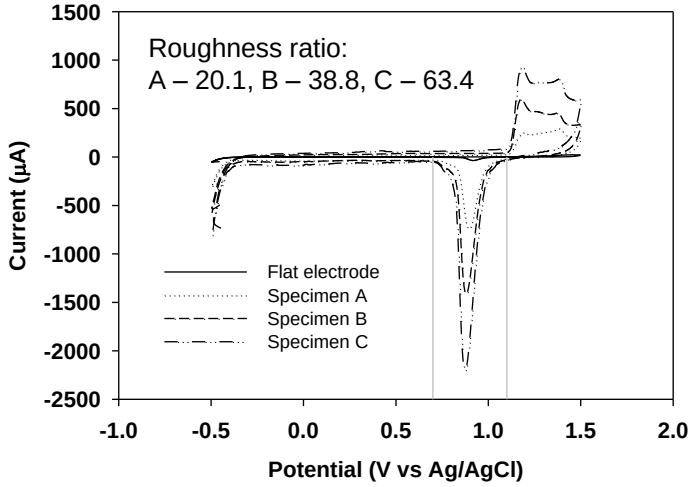


Strong 3D skyscraper nanopillar structures made with a cost-effective method

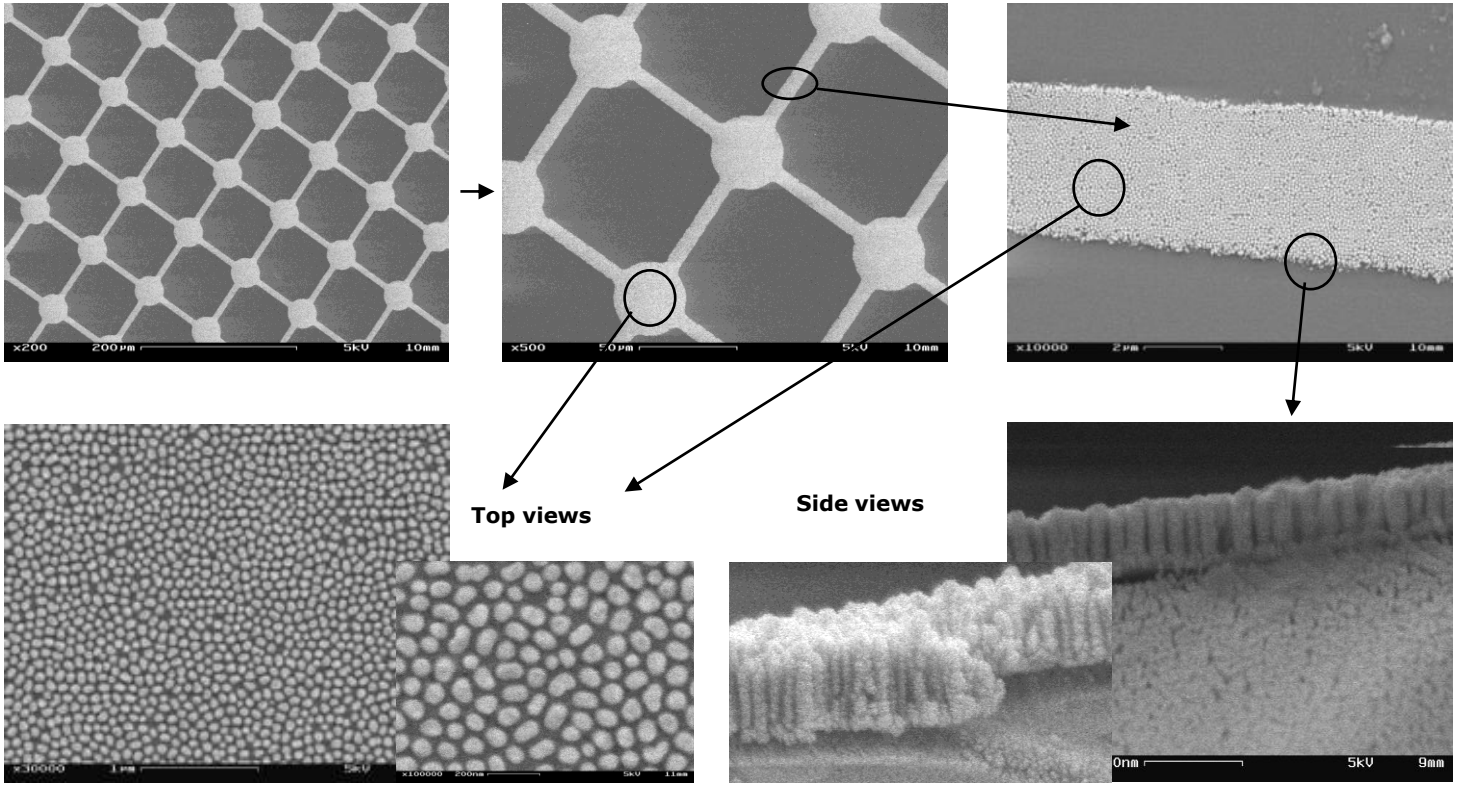




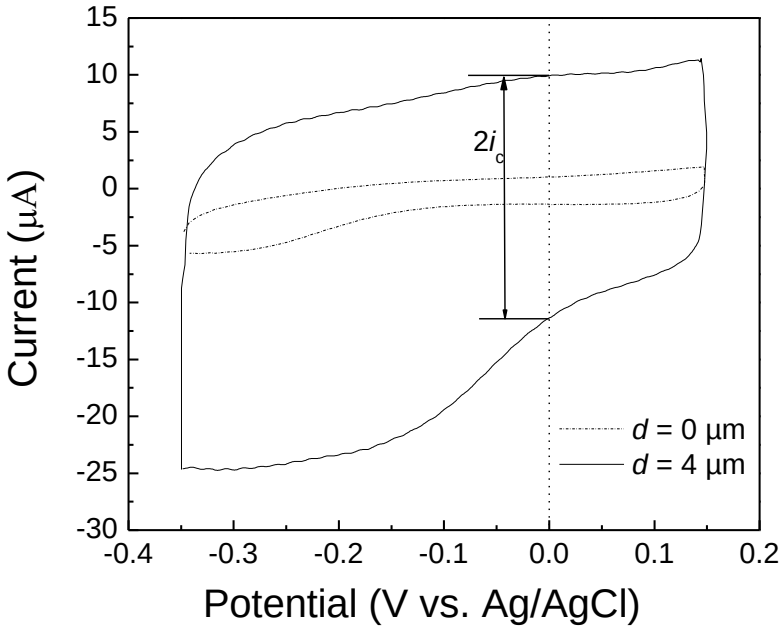


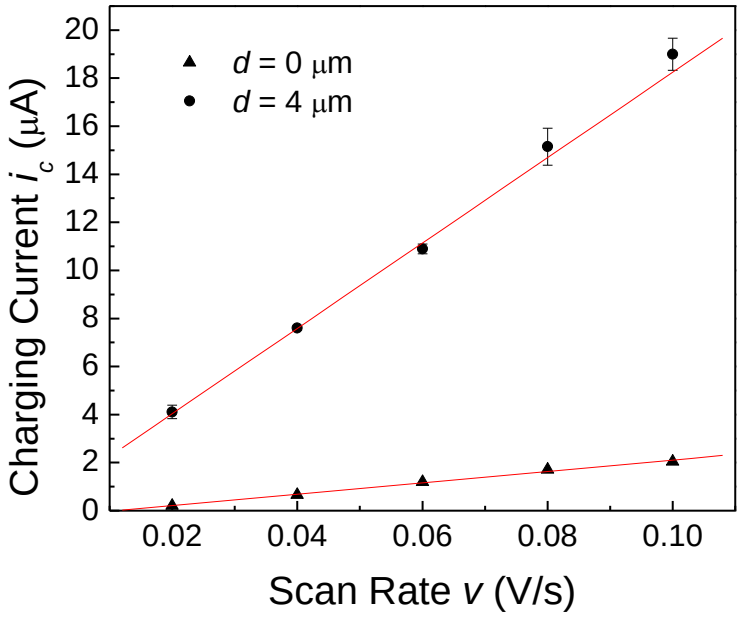


A patented process to form 3D skyscraper nanopillar structures: integrated micro and nano structures on glass substrates



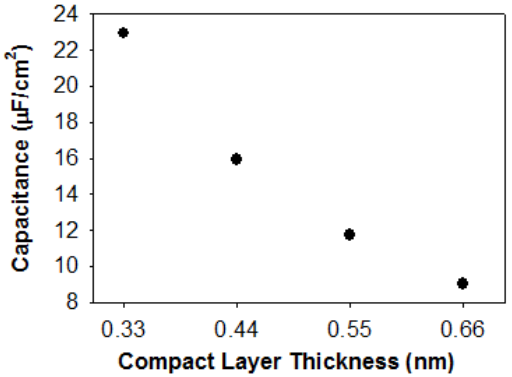
The benefit of skyscraper nanostructures: High capacitive charging current

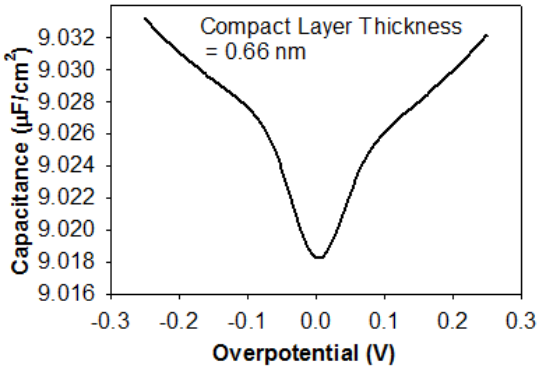


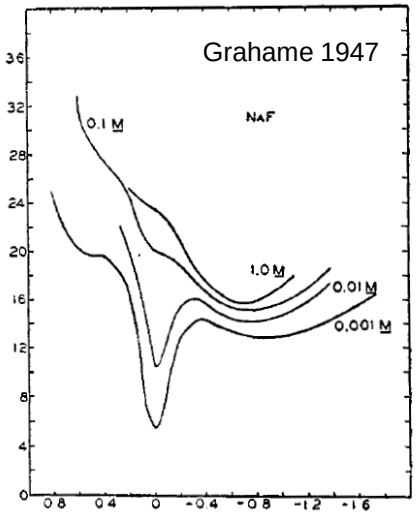


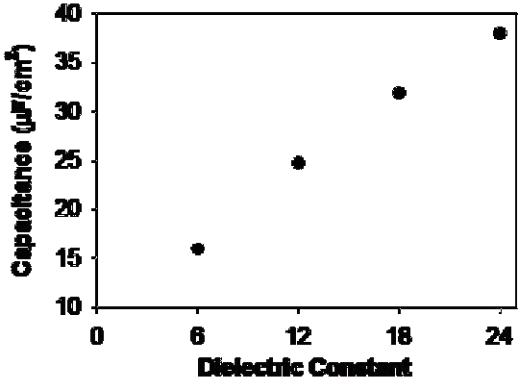
Capacitive charging current increases as the height of the nanopillars increases.

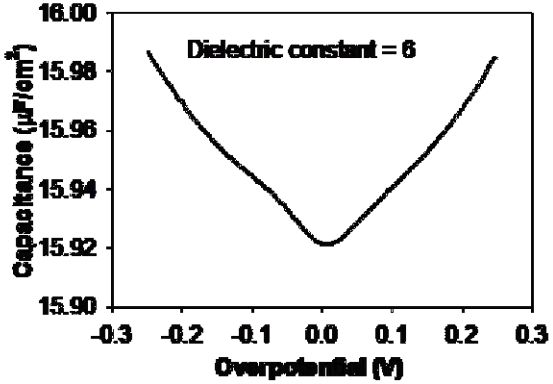
Capacitance at nano-scale surfaces

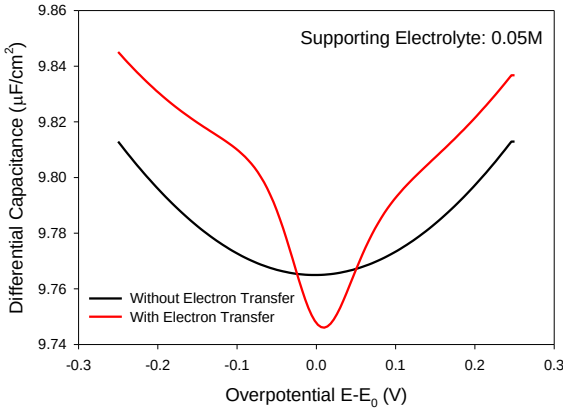






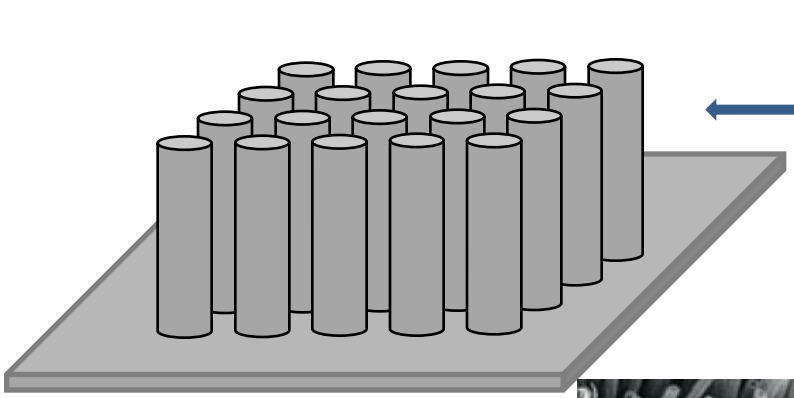


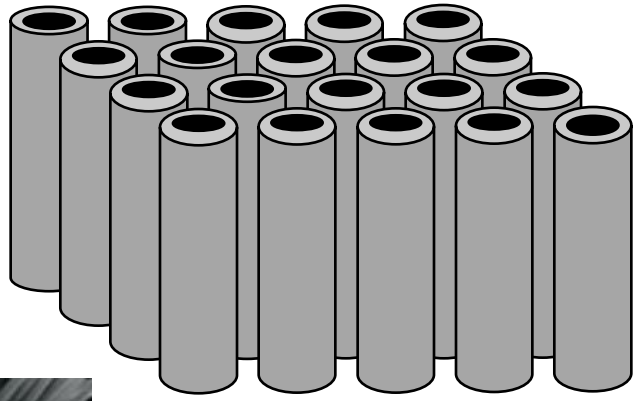




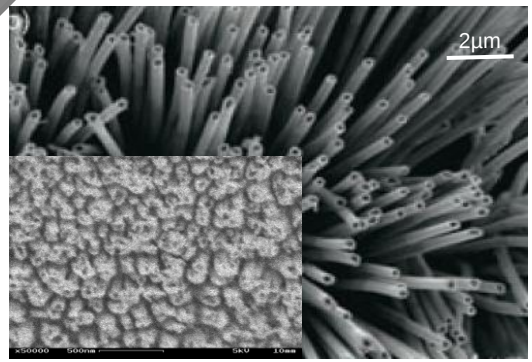
Proposed work

Objective 1: To further increase the surface area and the capacitance by fabricating *nanotube* skyscraper structures



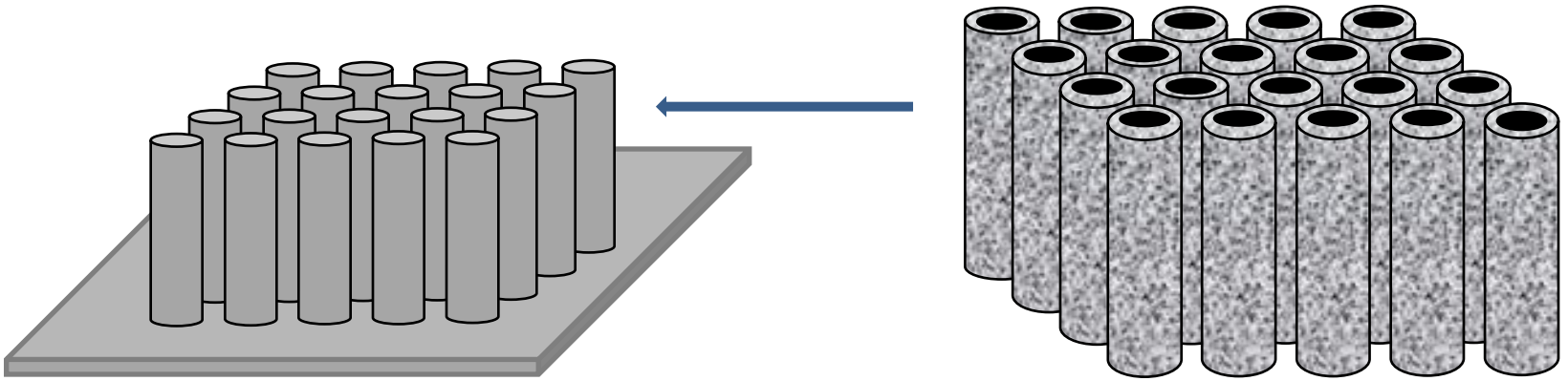


Nanotubes

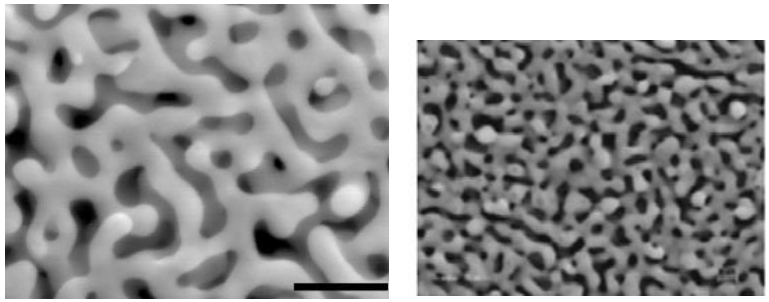


Proposed work

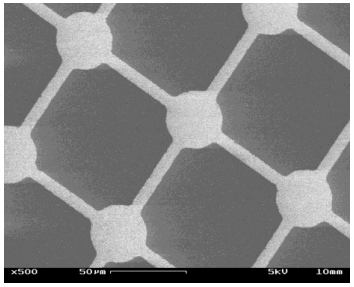
Objective 2: To further increase the surface area and the capacitance by fabricating *porous* nanotube skyscraper structures

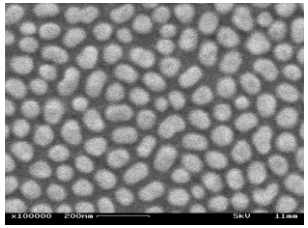


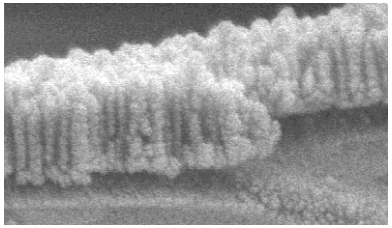
Porous Nanotubes

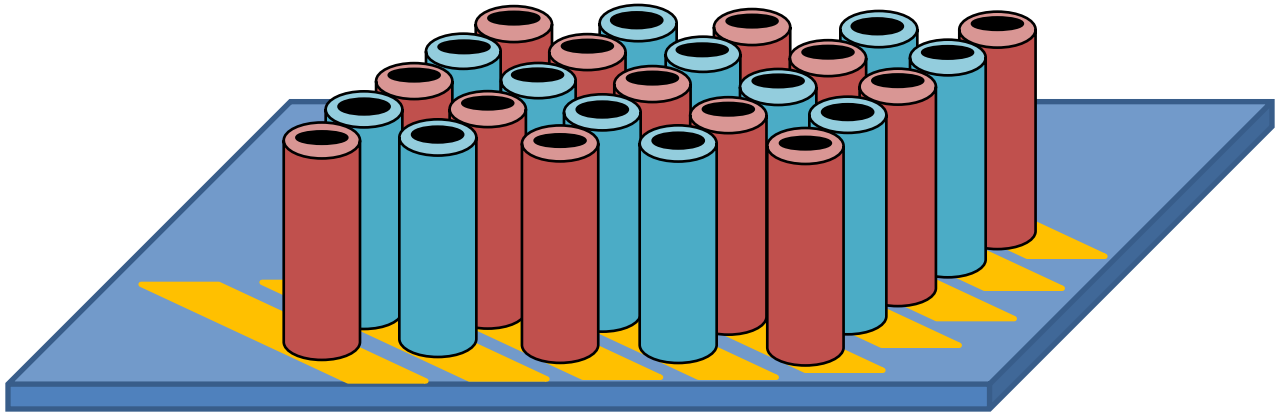


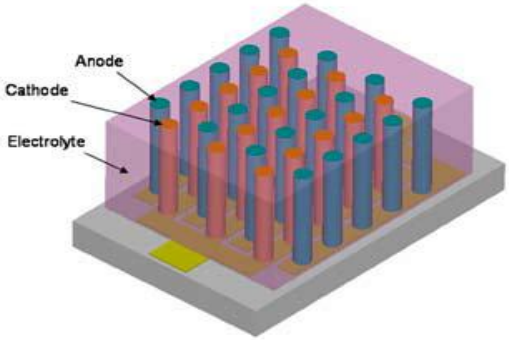
Proposed work
Objective 3: To maximize the capacitance through micro/nano patterning and structuring











First-year overall goal and deliverables:

Overall goal: development of 3D skyscraper structures made of *porous nanotubes*

Deliverables: fabricated structures, SEM images of the structures, and capacitive characteristics of the developed structures demonstrating the ultra high capacitance

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THANK YOU!