Synthesis of Nanowires for Performance and Efficiency Boost of Fuel Cells

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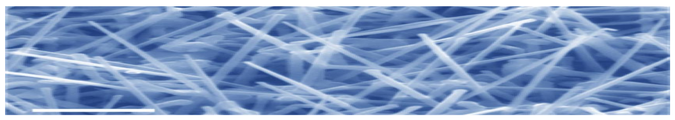
Abstract

Nanowires play an important role in a wide range of technologies because of their unconventional chemical properties, their efficient non-isotropic conductivity and their high surface area. The objective of the current study is to synthesize nanowires with a composition relevant to solid oxide fuel cell technology for higher anode conductivity, greater reactivity and lower contact resistances. We aim to improve the efficiency and performance of fuel cells by manipulating the composition and size of the nanowires using different types of metals such as Cerium (Ce), thereby producing cleaner energy by lowering the amount of pollution released. The experimental design includes the use of a working electrode (cathode) with a porous anodic aluminum oxide (AAO) template, a counter electrode (anode) and reference electrode, for producing various strengths of current to determine the optimal potential. Initially, metallic nanowires were generated by electrochemical deposition on a porous carbon electrode to determine the deposition conditions. Subsequently, deposition was performed on a nanostructured template that determines the wire size. A cyclic voltammetry method was used to determine the conditions of each metal in terms of their ability of getting deposited onto the working electrode. The nanowires were then synthesized by depositing the metal within the pores of the AAO using a Recurrent Galvanic Step (pulsed). Pulse deposition was used to minimize diffusion effects and current saturation. Results will be shown indicating the characteristics of the Ce wires generated. More complex materials will subsequently be attempted.

Introduction

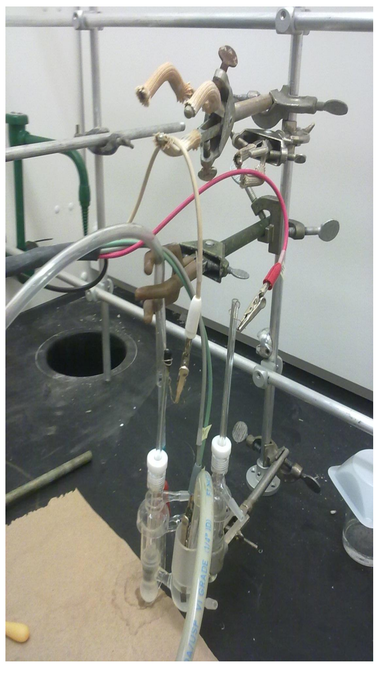
- Nanowires are tiny wires with a diameter to the order of nanometers
- These wires can be composed of a certain pure metal (Copper) or a mix of metals (Cerium – Nickel)
- The wires can be used in technologies such as fuel cells to boost efficiency and to reduce pollution.
- Nanowires allows for higher anode conductivity, greater reactivity and lower contact resistances due to the high surface area of these wires.



Objective

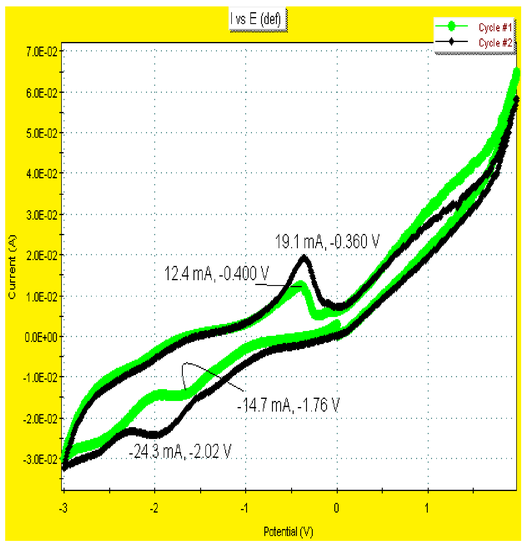
- Determine the potentials and currents for Cerium and other metals for electrodeposition to synthesize nanowires for higher anode conductivity, greater reactivity and lower contact resistances.

Methods

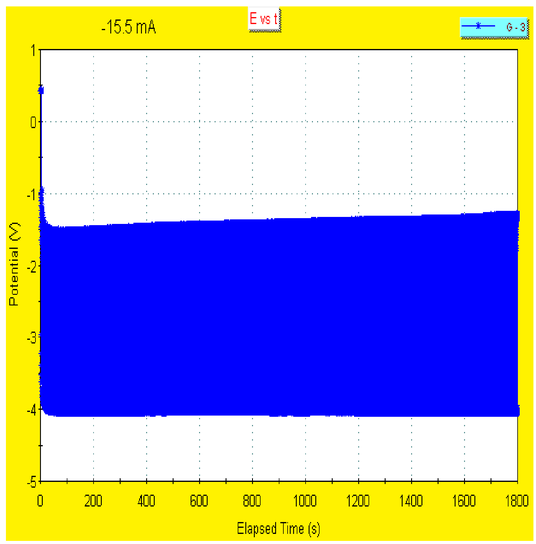


- To determine the deposition properties of the metal Cerium (Ce), a number of tests were conducted using the potentiostat.
- The cerium was deposited onto a working electrode (carbon)in order to determine the potential and current to be used for deposition.
- Once the potential values and current values were standardized, the carbon electrode was replaced with the porous anodic aluminum oxide (AAO) template.

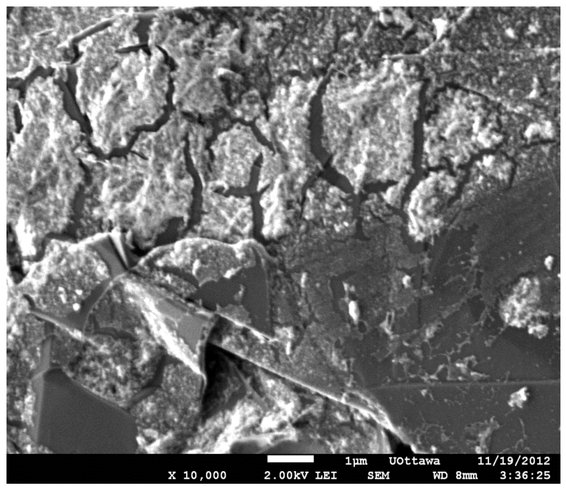
Results



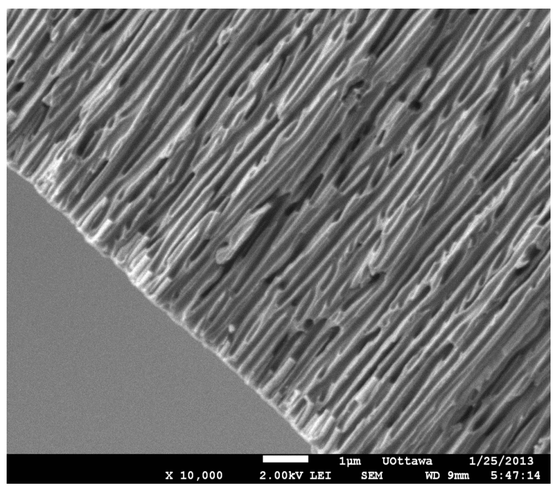
The graph of Cyclic Voltammetry produced by the potentiostat. Two cycles were recorded. The lowest peaks represents the reduction peak , while the highest peaks represents the oxidation peak.



The graph of Galvanic Step (Pulsed) produced by the potentiostat. The potential is allowed to pulse, continuous starting and stopping of the potential, in order to keep a constant current around the electrodes.

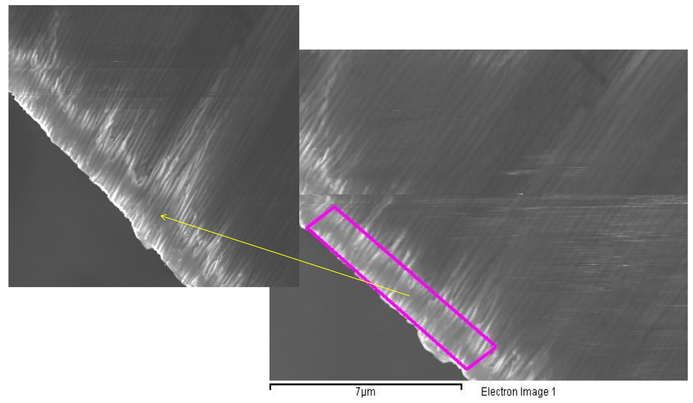


The SEM picture at 10000x magnification representing the electrodeposition of Cerium (Ce) on the carbon electrode. The large white areas are the place of deposition.



The Cerium deposition in the pores of the Anodic Aluminum Oxide (AAO) Template, allowing the Cerium to elongate vertically to form a wire structure.

EDS of AAO template



The Energy dispersive X-ray analysis shows the metal that has been deposited within the AAO template membrane.

Conclusion

In conclusion, the Cerium (Ce) metal was able to deposit in to the pores of the Aluminum Oxide (AO) Template. In future research, various other metals will be used to determine which metal is the best candidate for the synthesis of nanowires.

References

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