Bio-Inspired Model for Li-Ion Battery Separator

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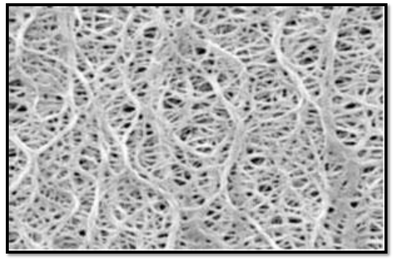
Introduction

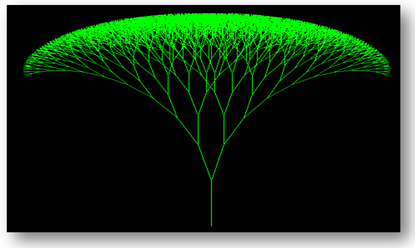
The goal of the project 'Simulation of Bio-Inspired Porous Battery Separators' is to generate a tool for users in order to create computer models of bio-inspired porous structures that resemble porous separators layer in lithium-based batteries. The simulated porous structure resemble a tree, with the branches as the porous channels. A tree model has to be generated using open-source programming tools such as Python and VPython. The tool has to be designed such that the branch length of the tree and the angle of the branch are user-defined parameters. The model, once generated, will be useful to study the performance of separator with tree-like porous morphologies in lithium-based batteries.

Background Information

Polymer separators, similar to battery separators in general, act as a separator of the anode and cathode in the Li-ion battery while also enabling the movement of ions through the cell. Additionally, many of the polymer separators, typically multilayer polymer separators, can act as “shutdown separators”, which are able to shut down the battery if it becomes too hot during the cycling process. These multilayered polymer separators are generally composed of one or more polyethylene layers which serve to shut down the battery and at least one polypropylene layers which acts as a form of mechanical support for the separator. If the performance of the separator improved, the performance and the service life will be easily improved.



Graph 1. Battery Separator under Microscope



Graph 2. 2D Model for “Binary Tree” Model

Methods

1. Our group put the battery separator under the microscope, we can find that, as the graph showed on the left(Graph 1), the micro-structure of the separator is porous.

2. From the micro-structure, we decided to develop a bio-inspired model, such as a “forest”.

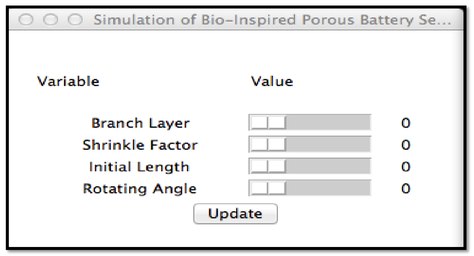
3.From the “forest” model, we decided to generate a single ”tree” model first.

4.By using Vpython, I generated a Binary Tree model shown as Graph 2.

5. From the basement of the 2D model, I tried to improve the model into

. **6.** Based on the 3D model, I set some user-defined parameters for users to control the “3D tree model”.

7. Design a GUI to let user to generate and control this model.



Graph 3. Simulation Tool GUI

Results

The result of this design is a tool, which can let the users to generate a tree and control the structure of the tree themselves. The GUI of the tool shown as Graph 3.

Conclusions

The simulation tool, once generated, will be useful to study the performance of separator with tree-like porous morphologies in lithium-based batteries.
In the future research, the tool can be developed into like “generate a forest”.

References

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