Designing an Electrolytic Cell using Carbon Nanopaper for Cube Satellite Propulsion

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Abstract:
Since 1999, over twenty one foreign and domestic universities have created cube satellite programs because of their lower fabrication and launch costs as opposed to conventional small satellites as secondary payloads. However, propulsion systems are still in early development. Previously NASA explored the possibility of electrolyzing a water payload to generate propellants for large scale spacecraft, hydrogen and oxygen, because of water’s ease of storage and low cost. The goal of this project was to design a small electrolytic cell to investigate whether it could be adapted for nanosats. Carbon nanopaper was selected as an electrode due to its high surface area which is 600 m²/g. The cell was designed hypothetically for a 1 N thruster.

Cube Satellites

- 4X4X4 inch (10X10X10 mm) satellites that usually carry one to two scientific instruments
- Can be built as a unit cell or many cubes, typically in a common longitudinal axis
- Cheaper to design and launch than conventional small satellites as secondary payloads
- Fabrication costs 40-60K
- Cal Polytech’s PPod Launcher is the standard means of deploying cubesat to desired orbit
- Propulsion systems in early development

Objectives
- Design small electrolytic cell to ascertain whether it can be adapted for cubesat
- Resulting hydrogen and oxygen gas used for warm gas microthrusters

Experimental Setup
- Based off of setup from paper by Papale
- Pressure sensors 100 psi range
- Water pumped using Range 9 12 volt fuel pump

Initial Design

- Water seeped through nanopaper
- Inner o ring seal ineffective due to flawed gland dimensions

Preliminary Results

- O Ring seals omitted from second design
- Clamp rings reconstructed without o ring glands
- Option I uses polydimethylsiloxane (PDMS) gaskets
- Option II replaces an aluminum ring and a PDMS gasket with a Teflon gasket
- Option III omits both PDMS gaskets and aluminum rings, replacing them with a solid Teflon ring and a porous layer of Teflon
- Option III may inhibit gas flow and another method of transporting electricity to the electrode must be redesigned

Redesign

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Future Work

- Reconstruct cell to test options I, II, and III
- Set up experimental design and collect data

Acknowledgements

References
1. Huang, Adam. “MEMS-based Warm Gas Thruster System for CubeSat Orbital Maneuver Applications.” Powerpoint Presentation