Can we levitate micron-thick materials near atmospheric pressure using light?

Motivation
- Sustained flight in the mesosphere is difficult as the air is too dense for satellites yet too thin for balloons
- Photophoretic levitation is a promising solution
- High pressure performance could allow low altitude take-offs

The Photophoretic Force
- Light absorption creates a temperature difference across a material’s thickness
- Temperature difference results in molecular gas flow and propulsion
- CNTs/Ge used as absorbers

Methods
- Tested three lightweight materials: Nanocardboard, Dandelion Pappi, and Mylar
- Materials were exposed to an LED light array
- Up to 8 sun’s worth of incident light flux
- Tested in chamber from vacuum to 1 atm

Results
- Nanocardboard: developed model that predicts atmospheric levitation to be possible
- Dandelion Pappus: tests with a diluted carbon nanotube (CNT) solution suggest that photophoretic force may be present
- Mylar Structures: spherical shapes are possible to fabricate and test

Force vs Pressure
- Lubrication Theory: gap = 1nm
- Lubrication Theory: gap = 1mm
- Weight
- Lubrication Theory: gap = 1mm

Dandelion Pappus
- Explored whether CNT coated dandelion pappi would create an observable photophoretic force
- Tested samples with and without light
- Tracked and analyzed the kinematics of the dandelion utilizing MATLAB

Mylar Structures
- Fabrication: fused together mylar sections coated with CNTs to form 3D shapes
- Created “orange peel” jig to help construction of a sphere

Links
- Digital Poster
- References
- Acknowledgements

Nanocardboard
- Model predicts that the following sample may levitate at atmospheric pressure: 300 um side length, 10 nm ALD alumina, 25 um channel thickness, with 8000 W/m² solar flux