### Design of CubeSat Solar Panels Considering Acoustic Pressure

**Devin Bunce: bunce2@illinois.edu, Erik Kroeker: kroeker2@illinois.edu, and Dr. Victoria Coverstone: vcc@illinois.edu**

**Premise**

During launch the rocket produces a tremendous amount of sound, averaging around 160 dB in the local area. This acoustic pressure can crack solar cells if the array wall deflects too much.

**Assumptions**

1. The satellite is subject to 130 dB of sound. This is a worst case approach because at greater sound intensities major electronic components begin to fail.
2. The sound pressure is uniform across the face of the CubeSat.
3. Analysis on the largest drum face will ensure that smaller drum faces also do not fail.
4. The edges of the drum face are firmly clamped such that it can neither rotate nor deflect. The corners of the drum face are screwed to the frame of the CubeSat.
5. The panel is a symmetrically supported thin plate.
6. The material properties are for standard carbon fiber for any thickness.

The University of Illinois at Urbana-Champaign has designed thin carbon fiber solar panels which simultaneously act as the outer skin of the CubeSat bus. The solar cell array runs down the panel, connected by an innovative ultrathin flexible power and data harness. The cells are very delicate and will crack if their center deflects approximately 1.8 mm relative to its edges.

An analysis is conducted to find the minimum thickness for the carbon fiber panel of the system under acoustic pressure. For worst case analysis, a 6U bus is chosen because it has the most surface area for acoustic pressure to act upon out of all the buses the University makes. On-board electronics will fail if they are subjected to an acoustic pressure greater than 130 dB.

The sound pressure is uniform across the face of the CubeSat. Therefore, this pressure level will serve as the upper bound to which the panels need to be designed before the solar cells crack under deflection.

### Boundary Conditions

The largest drum face across the entire side of a 6U CubeSat which has symmetric boundaries of two opposite sides clamped and two opposite sides simply supported. The two opposite simply supported edges have the following boundary conditions:

\[
\frac{\partial^2 w}{\partial x^2} + \frac{2}{y} \frac{\partial w}{\partial x} + \frac{\partial^2 w}{\partial y^2} = \frac{q}{y} = 3
\]

The simulation iterates over decreasing thicknesses until either condition is met. As a result the minimum thickness is found to be 0.1579 mm which generates the following surface plot over the entire plate:

**Results**

The simulation iterates over decreasing thicknesses until either condition is met. As a result the minimum thickness is found to be 0.1579 mm which generates the following surface plot over the entire plate:

**References**