Development of an Optically-Actuated Carbon Nanotube (CNT) Laminated Composite

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Overview
Carbon nanotubes (CNTs) are cylindrically shaped carbon molecules that can be constructed to support extremely large length to diameter ratios. In recent years, CNTs have been of interest due to their optical properties. Absorbing certain wavelengths causes them to deform. A circularly shaped carbon nanotube laminated disk can be actuated optically without physical contact, and results in bending deformation as a diaphragm. The goal of the research is to investigate the physical characteristics of actuating carbon nanotube optically, and to draw conclusions on performance towards applications as a micropump.

Key Findings
- The CNT laminated composite was designed and fabricated in-house. The design consisted of a sandwiched CNT laminate and PVC film with steel O-rings as boundaries. The composite was bound with adhesive.
- The performance of the composite was tested using a laser actuator and precision range sensor apparatus. Deflection of the composite was measured at various light intensities and frequencies.
- The data collected showed that the CNT composite has the following characteristics:
  - Max deflection ~ 23 µm at 70 mW/cm²
  - Quick rise time, ~ 160 ms
  - Significant transient response, warm up time required
  - Consistent magnitude of deflection after warm up

Impact
CNTs are currently used in body armor, solar cells, high-fidelity water filters, aircraft and spacecraft structural components, and electronics. The key findings of this research offer potential applications of the CNT composite as a diaphragm for precision control and manipulation of fluids within a small volume, and any application requiring remote, non-contact mechanical actuation. Thus, the research directly impacts the community by offering application to the medical field, national defense, and space sector.

Explanation
The key findings presented are pertinent to the AAS because of their potential application to spacecraft mechanical systems, precision optical systems, and precision microfluidics systems for space medicine.

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