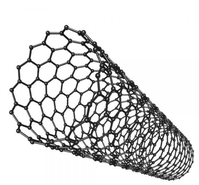
SCALABLE AIRCRAFT SMART SKIN: CARBON NANOTUBES AS AN INTEGRATED STRAIN SENSOR

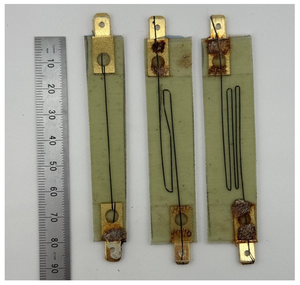
Christopher Johnson
Dr. Richard Liang, Dr. Cecil Evers

Introduction

- CNTs are small hollow tubes of specially arranged carbon that are well known for their impressive thermal, mechanical and electrical properties
- The goal is to explore using CNTs as an embedded strain sensor, allowing a composite material to act as a “smart-skin”

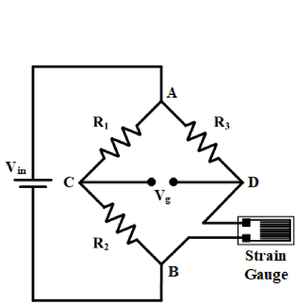


Samples



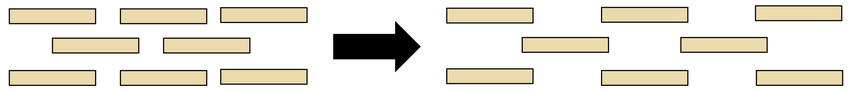
- Laid up by hand
- Vacuum bagged
- Autoclave to cure
- Solid brass tabs ensure less deformation of the CNT outside of the gauge length

Wheatstone Bridge

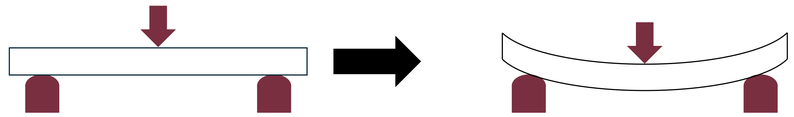


- Wheatstone bridge was soldered and connected to minimize noise and drift
- Voltage across the bridge is being measured rather than resistance directly

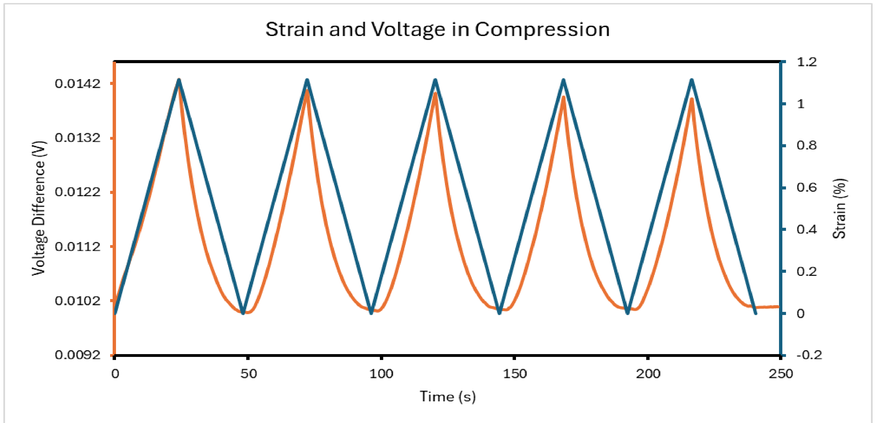
Results

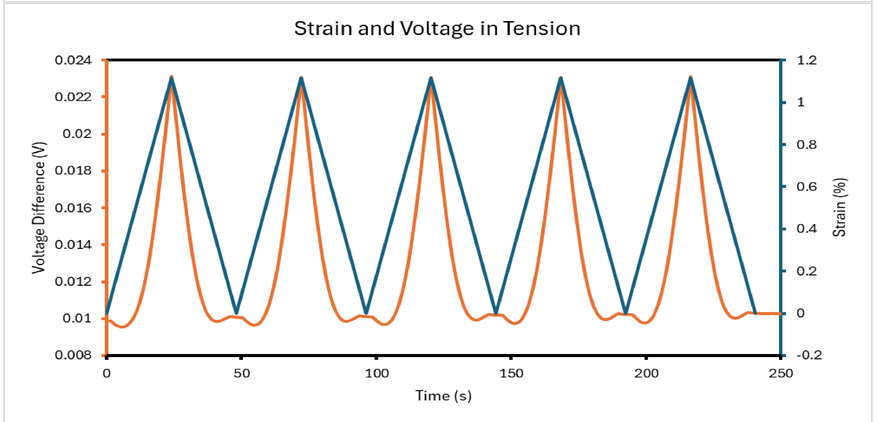


- CNT exhibit Piezoresistive properties meaning their resistance increases with deformation



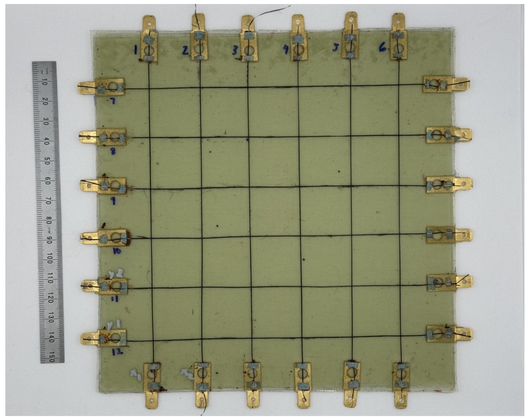
- 3-point bend tests with cyclic loading were performed with the yarn in tension and compression
- A strong relation between strain and resistance was found
- Signal amplitude is small but signal amplitude and CNT length showed a positive correlation
- In the future amplification will still be helpful to improve ease of application



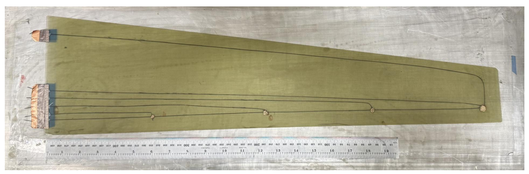


Current Work

- Panel for locating deformation
- By using a grid of CNTs the resistance of each CNT can be used to find the approximate location of deformation/impact



- Wing for scale version of a simple practical application
- The CNTs can be used to measure the deflection in a wing



- Software to automatically interpret the results of the strain gauge is being developed

Conclusion

- Usage of CNTs in a laminate as an embedded strain sensor shows strong promise
- Further testing will need to be done to improve their usability, and consistency of manufacturing
- Thanks to CNTs high thermal and mechanical resiliency embedded CNT sensors could become useful in high stress environments