SELF-DIAGNOSTIC, SELF-HEALING MULTIFUNCTIONAL FIBER OPTIC NETWORKS FOR COMPOSITE STRUCTURES

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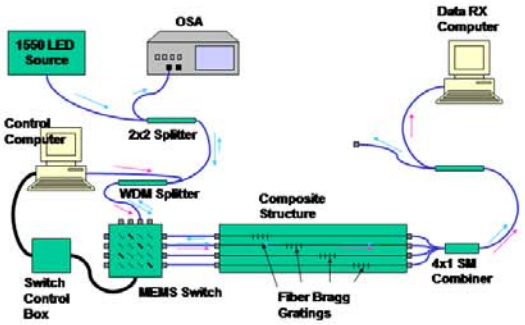
Project Goals

- Develop a smart fiber optic network that can interrogate the state of a composite structure while simultaneously providing for high-bandwidth communications.
- Define algorithms for monitoring and selection of fiber paths to provide "self-healing" functionality to network.
- Investigate techniques for further integration of fiber components and connectors directly into composite.

System Setup

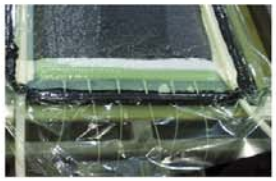


- Fiber Bragg Gratings (FBG's) used to measure strain in composite.
- Wavelength Division Multiplexing (WDM) allows simultaneous data transmission and monitoring of strain state of FBG.
- Micro Electrical Mechanical System (MEMS) based optical switch allows selection of fiber path through composite for both sensor and data, enabling monitoring and "self-healing" of network.

Value of Multifunctional Fiber Optic Networks for Composites

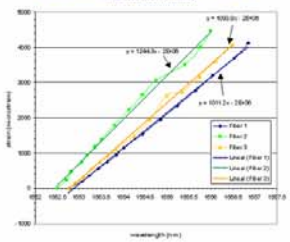
- Enables increased prognostics, reliability, and autonomous operation of composite systems.
- Fiber optics are inherently lightweight, immune to electromagnetic interference, and capable of high bandwidth communication.
- Form factor of fiber is compatible with in situ manufacturing using existing composite manufacturing techniques.

Composite Fabrication



- Fibers embedded prior to resin transfer process.
- For current process, fiber egress is located at end of composite span.
- Fabrication methods are being investigated to implement mid-span fiber egress and/or embedded connectors.

System Strain Test



- Grating demonstrates linear response to strain for entire range of composite.
- Fiber strain sensor temperature sensitivity will be dominated by CTE of composite.
- Temperature drift of bare sensor is ~10μ-strain/°C.

Network Test

- Video transmitted though composite via fiber optic network while simultaneously measuring strain on composite.
- FBG strain measurement and network transmission remained stable up to nearly the yield point of the composite.

Future Work

- Continue to integrate fiber network functionality into composite structure.
- Demonstrate approaches to embedding networks into cylindrical structures.
- Evaluate stability and survivability of network in severe shock environments

Acknowledgements

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