Ground Testing of Satellite Structures using Optical PM-FBG Sensors to Simultaneously Measure Strain and Temperature

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FBG challenges

- Limited mechanical strength due to strip and recoat process
- Cost effectiveness of multiplexing tabletop FBGs
- Standard FBG: cross sensitivity for strain (ε) and temperature (T)
- FBGs in birefringent or Polarization Maintaining (PM) fiber: limited sensitivity to simultaneously measure ε and T

Interrogator challenges

- Stability limited to pico-meter range
- Reliability and absolute accuracy
- Polarization can impact performance

PM-FBG interrogation approach

- Individual λ₁ and λ₂ FBG peaks change with respect to Strain (ε) and Temperature (T) similar to standard FBGs
- λ₁-λ₂ peak separation is mainly governed by temperature dependent birefringence
- A set of linear equations are solved to extract ε and T

Temperature and strain calibration for a single PM-DTG

- Temperature stability during a strain calibration ∼ ± 0.2°C

Conclusion

PM-DTGs from FBGS together with the FAZT I4 interrogator allow for separation of strain and temperature effects with high accuracy, and the interrogation of PM-DTG sensor arrays using different polarization control techniques. Temperature stability of a PM-DTG during a strain calibration was found to be approximately ±0.2°C.

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