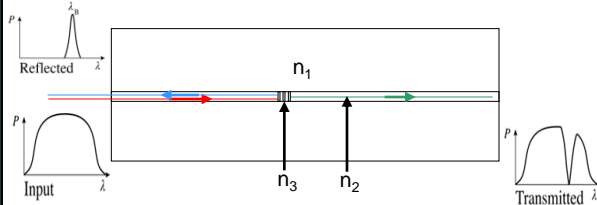


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FIBER BRAGG GRATING

The elementary fiber Bragg grating (FBG) comprises a short section of optical fiber in which the core refractive index is modulated periodically by exposure to UV light.



$$\lambda_B = 2n_{eff}\Lambda$$

λ_B : Bragg wavelength

n_{eff} : effective refractive index of the guided mode in the fiber

Λ : period of the refraction index modulation.

$$\frac{\Delta\lambda_B}{\lambda} = C_\epsilon \epsilon + C_T \Delta T$$

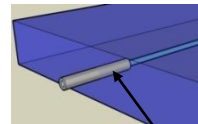
ϵ : strain (Sensing principle)

T : temperature

C_ϵ : coefficient for strain

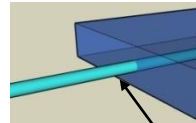
C_T : coefficient for temperature

OBJECTIVE



embedded ferrule

- ◆ Embedded connectors
 - Connectors (e.g. ferrules) embedded in composite structures
 - Bulky and requires side egress

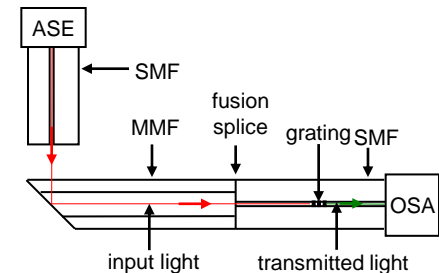


trailing fiber

- ◆ Trailing fibers
 - Fibers enter/exit at ingress/egress points
 - Very fragile

APPROACH

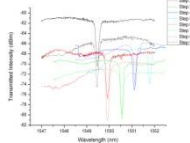
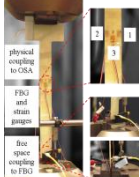
Fusion splice multi-mode fiber (MMF) to single-mode fiber sensor, then integrate 45-degree mirror onto MMF to enable free-space coupling in the surface normal direction.



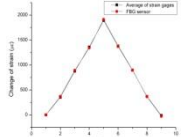
ASE: amplified spontaneous emission light source
OSA: optical spectrum analyzer

STRAIN TEST

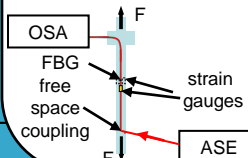
Compare strain gage response to free space coupled FBG sensor



optical spectra

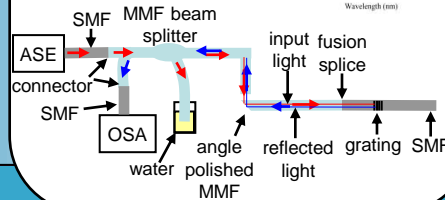
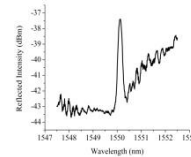


comparison of FBG and strain gauges



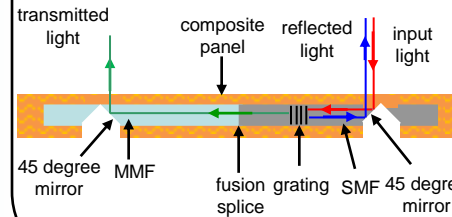
REFLECTION MEASUREMENT

The reflection of un-embedded FBG was measured using free space coupling.



FUTURE WORK

- ◆ Completely embedded FBG sensors with no pigtailling.
- ◆ The challenge is to achieve efficient coupling after fibers are embedded.



CONCLUSIONS

- ◆ First ever demonstrated non-contact interrogation of FBG sensors.
- ◆ More robust and less bulky than conventional coupling.
- ◆ Excellent agreement between free-space and control measurement techniques in strain test.

ACKNOWLEDGEMENTS

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