Magnet-assisted Fiber Optic Sensing for Internal and External Corrosion-induced Mass Losses of Metal Pipelines under Operation Conditions

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Main Objective

This project was awarded to Missouri S&T in order to develop and demonstrate an integrated system of multiple FBG/EFPI and multiplexed LPFG sensors for internal and external pipeline corrosion monitoring at critical sections under operation conditions.

$$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos(\frac{4\pi n_0 L}{\lambda} + \varphi_0)$$

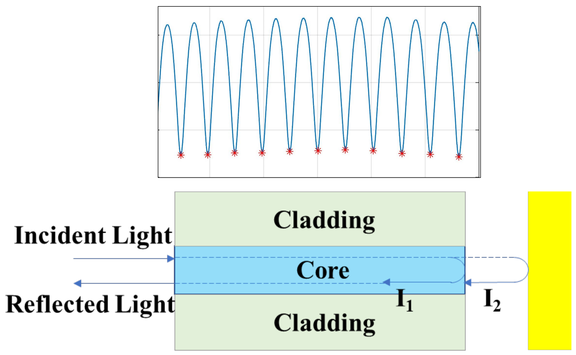

Figure 1. Principle and fringe pattern of EFPI.

$$\lambda_{res} = (n_{eff}^{co} - n_{eff}^{cl,0j})\Lambda$$

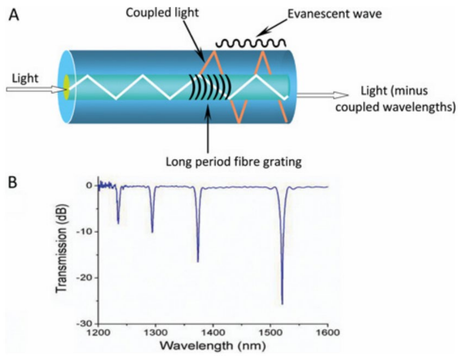

Figure 2. Resonance wavelength equation and coupling effect of the LPFG

Project Approach

(1) Design a high sensitivity, magnet-assisted, hybrid sensor of Fiber Bragg Gratings (FBG) and extrinsic Fabry-Perot interferometer (EFPI) for simultaneous measurement of temperature and pipe wall thickness.

(2) Develop graphene-based Fe-C coated sensor with long period fiber gratings (LPFG) for accurate measurement of pipe wall thickness due to external corrosion.

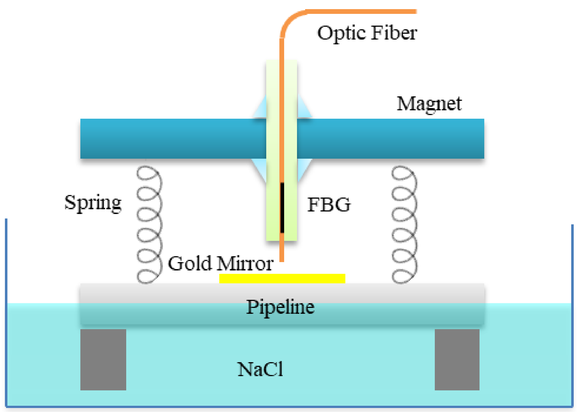

Figure 3. Schematic view of the hybrid EFPI/FBG sensor set up.

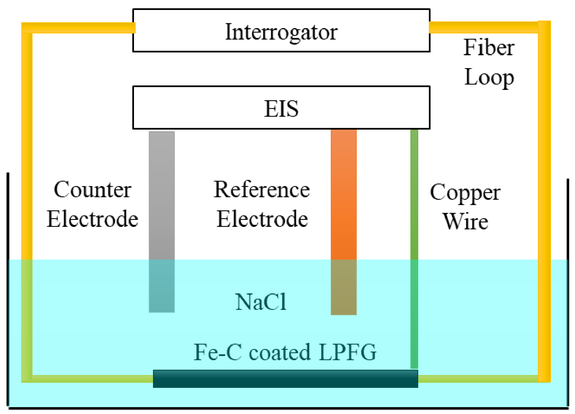

Figure 4. Optical spectra and EIS data acquisition of the Fe-C coated LPFG sensor.

Results

(1) The proposed sensors can measure the corrosion induced mass loss of the pipeline accurately in both external and internal setup.

(2) The combined EFPI/FBG can simultaneously measure the corrosion induced mass loss and temperature.

(3) The graphene-based Fe-C coated LPFG sensor is very sensitive to the corrosion-induced mass loss of the Fe-C layer.

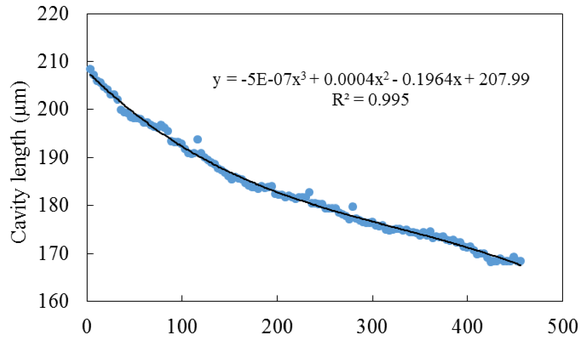

Figure 5. Cavity length change of the EFPI vs. steel plate thickness.

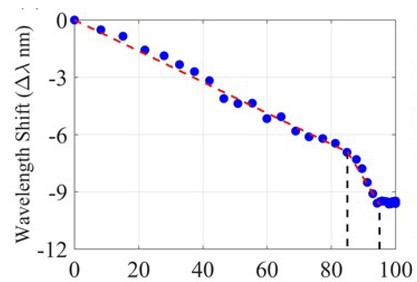

Figure 6. Resonance wavelength shift of the LPFG vs. corrosion-induced mass loss of the Fe-C layer.

Acknowledgments

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References

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