The Birefringence Change of Optical Fiber Polarizer with Fe-C Film in Corrosive Solution

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Abstract: The simulation is used to analyse the field distribution of the cross-section of the side-polished optical fiber coated with a Fe-C film. As a result, the relation between ER and corrosion evolution of Fe film can be built.

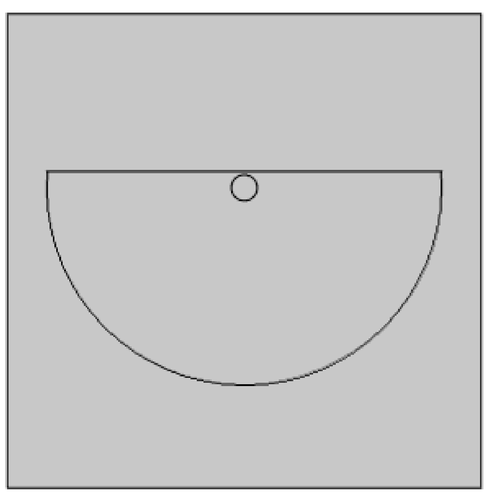

Fig1. geometric graph of simulation

Computing method: Electromagnetic Waves, Frequency Domain is used as physics interfaces. A scattering boundary condition is used to reduce the reflection from the boundary.

$$\eta(\mathrm{dB}) = -10\log(\frac{I^2_{Radiated}}{I^2_{Total}})$$

$$\mathrm{ER(dB)} = -10\log\frac{I^2_{TM}}{I^2_{TE}}$$

The strengthes and leakage power of TE/TM modes are calculated. The ER value, which is the main parameter of the calculations, is derived according to the calculated power of TE and TM fields in the fiber core.

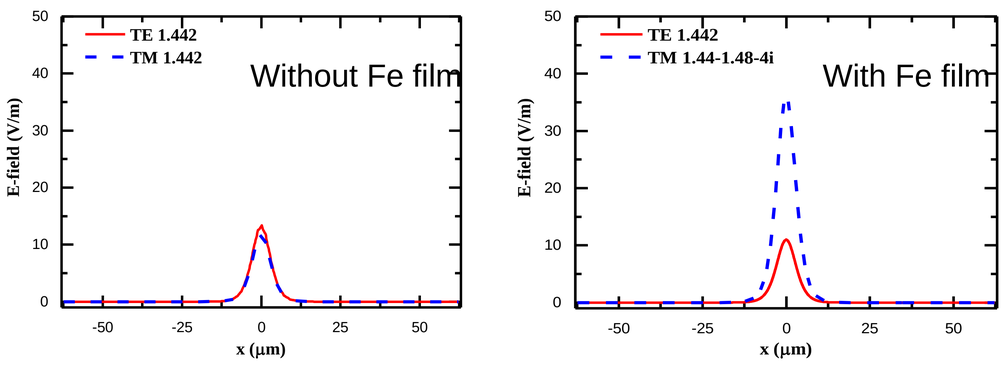

Fig2. The E-field strength of TE and TM modes along the interface of the cross section

Result: By specifying the refractive index of coating layer to be Fe, Fe2O3 or surrounding media (i.e. no coating layer), different ER values can be obtained, as shown in Fig.5.

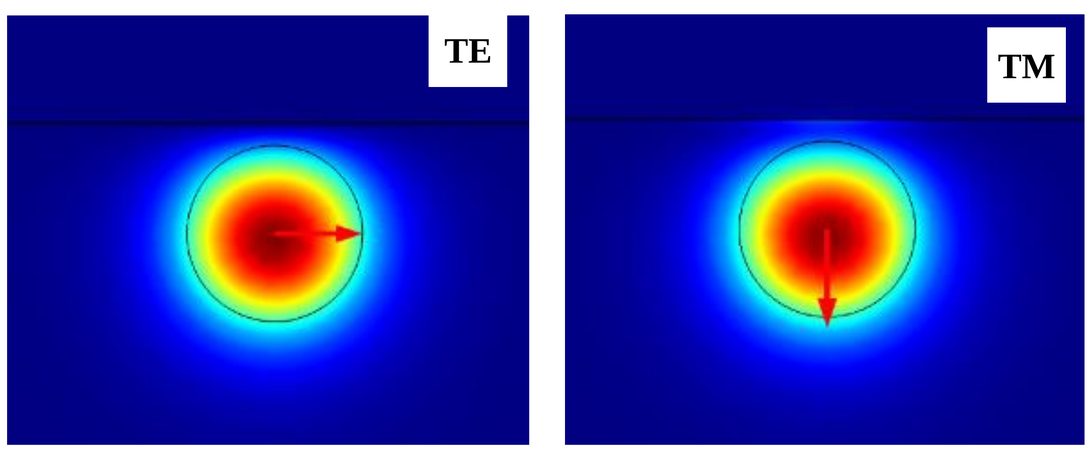

Fig3. D-shaped optical fiber with Fe film

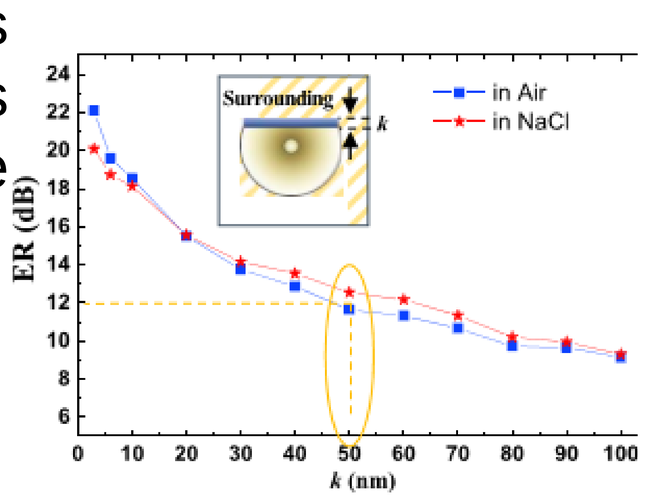

Fig4. The calculated ER values with varying thicknesses of iron film, k, for Model B in surrounding media (air and NaCl solution).

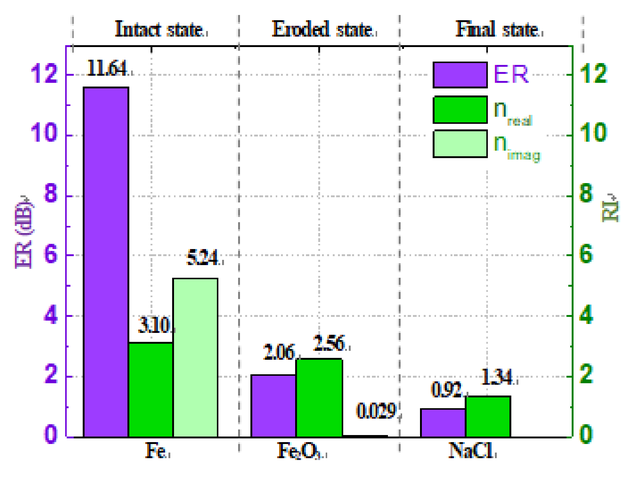

Fig5. The evolution of ER value, the real (n_{real}) and imaginary (n_{imag}) part of RI value for the three states during the corrosion process.

Conclusion: The result of the simulation reveals the corrosion of Fe-C film is related to the ER values, which is consistent with the experimental result. It turns out that the extinction ratio decreases during the corrosion process. The proposed polarizer can be used for monitoring the early stage of metal corrosion.

参考文献：

1.Hu W, Ding L, Zhu C, et al. Optical Fiber Polarizer with Fe-C Film for Corrosion Monitoring[J]. IEEE Sensors Journal, 2017:1-1.