PROJECT 6: Multi-Objective Bayesian Optimization for Transparent Electromagnetic Interference Shielding with Thin-Film Structures

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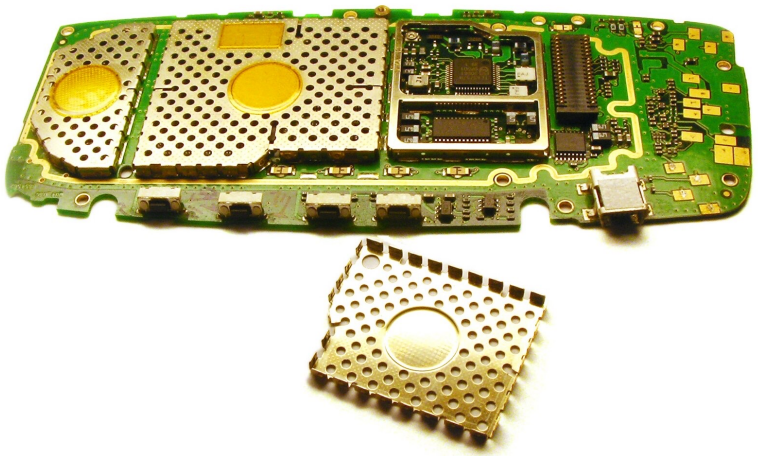
Electromagnetic Interference Shielding



- Protect a device from radio-frequency interference.
- Transparency is required for specific applications such as spacecraft windows.

Problem Formulation

- Simple thin-film structures are used for electromagnetic interference shielding.
- Transmittance and shielding effectiveness are considered as objectives being optimized.
- Material and thickness for each layer is selected by Bayesian optimization.

Multi-Objective Bayesian Optimization

$$\mathbf{x}^* = \arg\max(f_{\text{trans}}(\mathbf{x}), f_{\text{effec}}(\mathbf{x}))$$

- Since two objectives are black-box, multi-objective Bayesian optimization is employed.
- Random scalarization for both acquisition functions are used for multi-objective Bayesian optimization.

Search Space

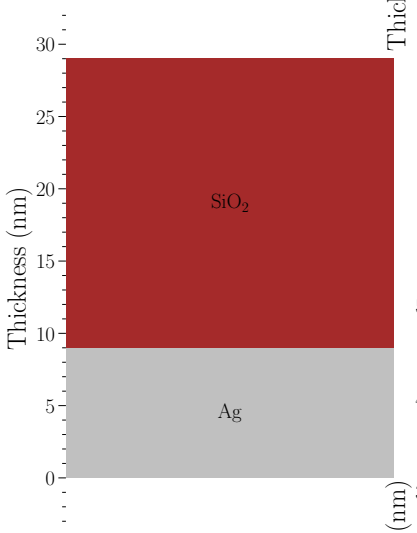
- Material choices
  - Ag, Al, Al2O3, Cr, Ni, Pd, Si3N4, SiO2, Ti, TiN, TiO2, W
- Thickness range
  - [5, 20] nm

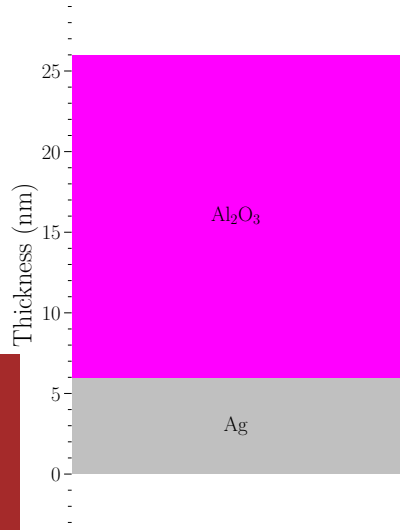
Bayesian Optimization Setting

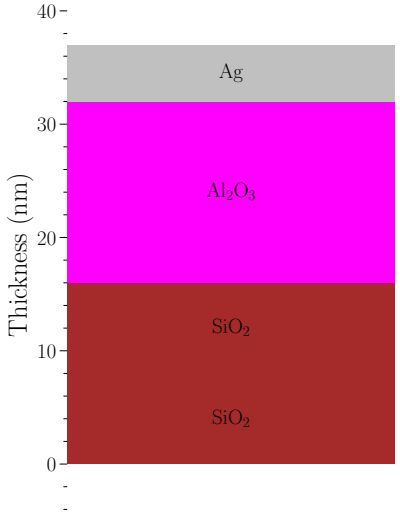
- Gaussian processes with the Matérn 5/2 kernel
- Expected improvement

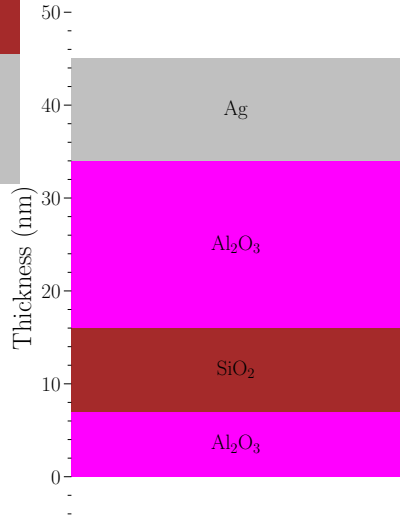
$$a_{\text{trans}} + \frac{w_{\text{effec}}}{w_{\text{trans}}} a_{\text{effec}}$$

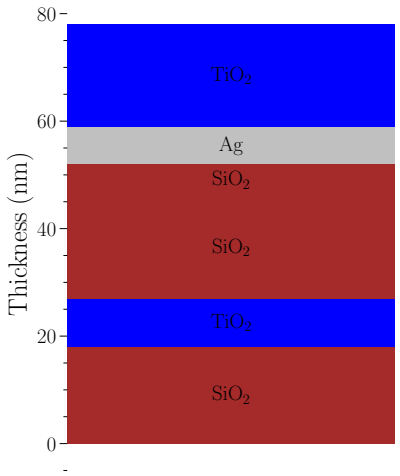
Experimental Results

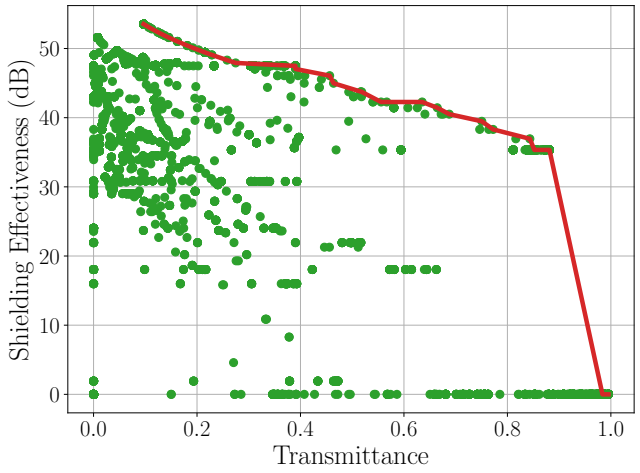




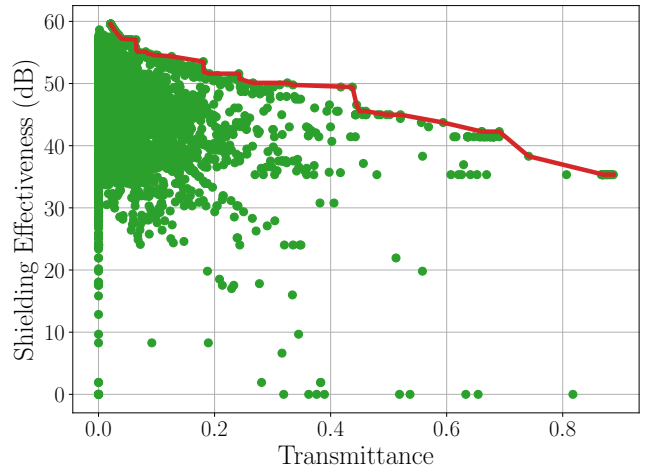




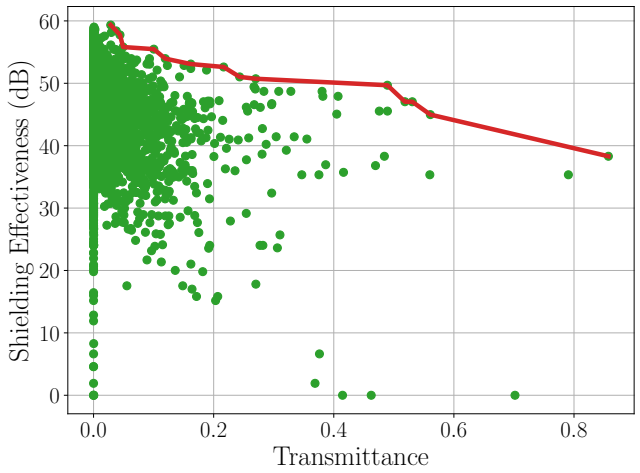




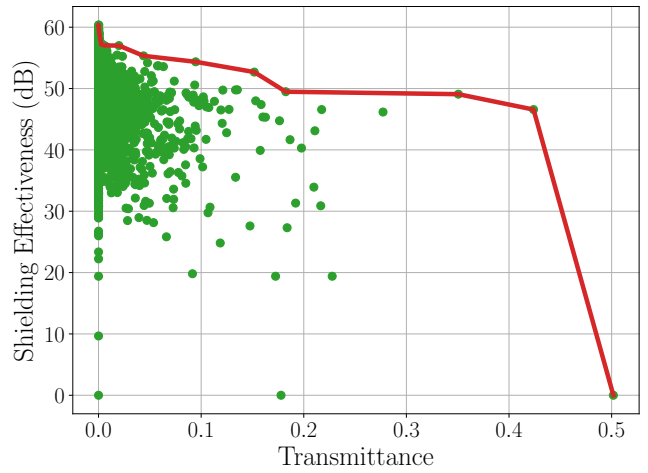
Two-layer system



Four-layer system



Six-layer system



Eight-layer system

Thank you!