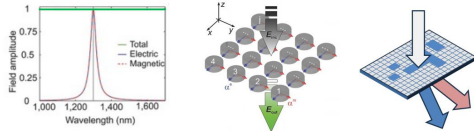# Meta-Grating Spectral Beam Deflector with Topology Optimization and Stochastic Gradient Descent Algorithm

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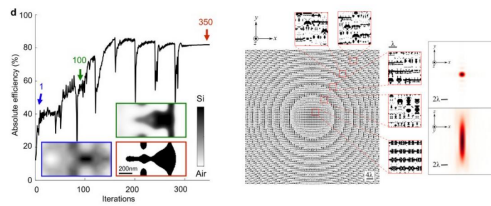
Motivation

- Constant-amplitude optical design is challenging.
- Enabled by inverse design of metasurfaces.

- **Objective:** Wavelength-independent 1st order diffraction with constant amplitude.

Related Work

- Topology optimization: unit cell / large scale.
- Local optimum issue.

References

[1] Decker, Manuel, et al. Advanced Optical Materials 3.6 (2015): 813-820.
[2] Lin, Zin, et al. Optics express 27.11 (2019): 15765-15775.
[3] Sell, David, et al. Nano letters 17.6 (2017): 3752-3757.
[4] Jiang, Jiaqi, et al. Optics express 28.9 (2020): 13670-13681.

New Technique - SGD

- Topology optimization pipeline:

Adjoint simulation enables backpropagation.
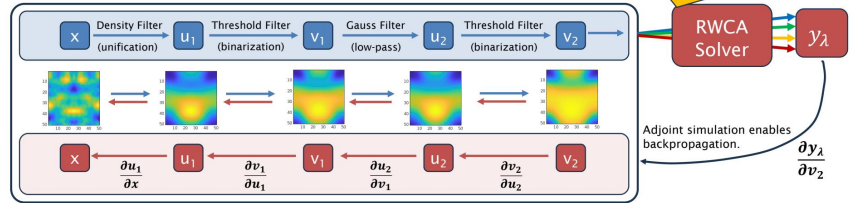
- $v_2 \in \mathbb{R}^{M \times N \sim 1000}, y_\lambda \in \mathbb{R}^{P \sim 10}$, y_λ correlated measurements.
- SGD: 1. enable more measurement; 2. overcome local optimum.

$$\min_{y_\lambda} \left| y_\lambda - y_{\lambda,gt} \right|_2^2$$

Experimental Results

- First-order diffraction spectrum optimization, ground truth set as diffraction(1st) = 1.