**Date:** 23rd December 2023

**Title:** Anti-Reflective Coating with Multiple Layers

**Purpose:**

I intended to employ the guidelines I fortuitously obtained from COMSOL for creating a model of an anti-reflective coating. My goal is to glean insights from this model, which I plan to apply to my own model through reverse engineering. The original instructions are available [here](https://www.comsol.com/model/anti-reflective-coating-with-multiple-layers-19279).

**Experimental setup:**

The detailed modeling instructions are available at this [link](https://www.comsol.com/model/anti-reflective-coating-with-multiple-layers-19279).

**Results:**

Regrettably, I've been unable to achieve any results due to the absence of the ‘Ray Optics’ module in my setup. I've already reached out to COMSOL Customer Service regarding this issue, and I'm awaiting their response. This situation is quite frustrating as it hinders my progress; I can't even move forward with defining parameters without this module. I also attempted to run the mph file, available at this [link](https://www.comsol.com/model/anti-reflective-coating-with-multiple-layers-19279), but COMSOL displayed an error stating it couldn't generate the study because the ‘Ray Optics’ module is missing.

**Conclusions/Future work:**

I'm optimistic that the issue will be resolved shortly. There's a concern about potential extra costs, but I'm hoping it won't be too expensive. In the meantime, the one aspect I can focus on is my writing.

**Date:** 22nd January 2024.

**Title:** Chapter 1 Edits.

**Purpose:**

In our recent weekly meeting with Professor Hudgings, which Fernando and I attended, she indicated that she would address the issue of the missing module. She also advised me to contact Prof. Higdon for his views on acquiring the Ray Optics module, as he is the registered holder of the COMSOL license. Meanwhile, she has tasked me with making revisions to Chapter 1.

**Experimental setup:** <https://www.overleaf.com/project/652ebe35032010e71fe7d54f>

**Results:**

I have made corrections and edits to the sections highlighted by Prof. Hudgings. Additionally, I have added a provisional bibliography.

**Conclusions/Future work:**

I will focus on referencing the figures and elaborating on them within the main text of the chapter. Additionally, Prof. Hudgings has directed me to include an extra subsection for a literature review.

I have updated Chapter 1 by incorporating a literature review section. Additionally, I commenced work on Chapter 3, detailing the process of constructing the busbar model, guided by tutorials found on the COMSOL website.

**Date:** 26th February 2024.

**Title:** Generating anti-reflectance plots for thin dielectric films.

**Purpose:** After much waiting, I finally have the Ray Optics module that I need to do perform the (anti)-reflectance measurements on COMSOL.

**Experimental setup:**

I initiated my exploration by engaging with the COMSOL Multiphysics 6.0 tutorial titled “Anti-Reflective Coating with Multiple Layers,” accessible in the repository within COMSOL>Tutorial Resources. This exercise served as a practical introduction to familiarize myself with the COMSOL interface, following the detailed instructions provided in the document.

**Results:**

**A graph with a blue line

Description automatically generated**

**A graph showing a number of different colors

Description automatically generated with medium confidence**

The structure in question consists of two quarter-wavelength layers, one of CeF3 and the other of MgF2, with respective refractive indices of 1.63 and 1.38. I successfully duplicated the outcomes depicted in the tutorial document. It's important to highlight that the spatial dimensions of the results I obtained are two-dimensional.

**Conclusions/Future work:**

Although the tutorial provided clear instructions, there remain questions regarding the necessity of certain steps. For example, the initiation of air and glass materials was specified, yet their application within the dielectric films remains unclear to me.

Additionally, I plan to compare the graphs generated by COMSOL with those found in an Optics textbook. Despite the use of different materials in each scenario, the similarity in the graph shapes provides a sense of reassurance.

Moving forward, my aim is to expand this analysis to a 3D model. However, a deeper understanding of the rationale behind each step in the current model is essential before proceeding.

**Date:** 28th February 2024.

**Title:** (Anti)-Reflective Coating with Multiple Layers

**Purpose:**

To finish the tutorial showing anti-reflectance for both the quarter-quarter and the quarter-half-quarter wavelength case.

To check whether my results make sense theoretically by checking it against the math in the Pedrotti book.

To start on showing the same but for the high-reflectance case.

**Experimental setup:**

The detailed modeling instructions are available at this [link](https://www.comsol.com/model/anti-reflective-coating-with-multiple-layers-19279).

For the high-reflectance case, I aimed to at least replicate the quarter-quarter wavelength shape given in the Pedrotti Optics book which is:

A diagram of a graph

Description automatically generated

**Results:**

I was able to confirm that the 2D anti-reflectance model indeed makes sense. The calculations can be found [here](https://notability.com/n/1VYxj4AFG5p9SJnYZE_~qD).

Moreover, I was able to quickly model the high reflectance case, and this is what I obtained:

A graph with a blue line

Description automatically generated

It matches what is in the Optics book.

**Conclusions/Future work:**

I am now torn between further investigating the high-reflectance regime in 2D or trying to replicate my anti-reflectance results but now in 3D. I have asked Professor Hudgings for advice on what to do via email. I also realize that the next step would be to plot reflectance versus angle of incidence since my results thus far assume the (naïve) case where the rays normally meet the surface. More work is also needed to clarify what exactly each step in the 2D anti-reflectance case does.