CAS 741: Problem Statement
Surface Plasmon Dynamics Finite Method

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Table 1: Revision History

Date	Developer(s)	Change
2020/09/20	Shayan Mousavi	Initial Draft
2020/09/24	Shayan Mousavi	Draft Revised

1 Introduction

Surface plasmons are harmonic oscillations of free electrons on the surface of materials with high electron density. These oscillations are electromagnetic waves following Maxwell's equations and are excited by an incident electromagnetic wave (photons or swift electrons). Surface plasmons depend on the geometry, dielectric function, and density of charge carriers on the surface. Surface plasmons can absorb the energy of the incident light and generate hot charge carriers. These generated energetic charge carriers can be used for different purposes such as accelerating chemical reactions, designing invisibility cloaks, generating local heat for killing cancer cells, and biosensing. Being able to simulate the electromagnetic activities on the surface gives a great insight into studying and designing novel plasmonic systems.

2 Objective

The purpose of the Surface Plasmon Dynamics Finite Method (SPDFM) script is to solve Maxwell's equations applied for surface plasmons in a time domain, for a discretized (meshed) anisotropic and varying dielectric environment composed of different materials. The SPDFM script provides the user with 3D electromagnetic vector field over the entire geometry.

SPDFM will be launched in two phases. The first phase is due December 2020, and measures the generated electric potential with a pulsed illumination in a time domain for a discretized homogeneous dielectric space. The second phase is due February 2021, and calculates the electromagnetic vector field generated with a pulsed illumination for an anisotropic environment in a time domain. In both phases partial differential equations will be solved using FEniCS finite element toolbox.

3 Interest

Available open-source softwares are either simulating more general optical properties and are not adopted for plasmonic properties specifically or simulating the plasmonic response with too many restrictions. Among the limitations present in the current surface plasmon simulation scripts are constrains on the dielectric functions or particle size, and no information on the evolution of surface plasmons with time. Although potential equivalent licensed softwares might exist, their source code is hidden which forces the user to blindly trust them. Interested stakeholders in this project may include researchers and industries that are exploring areas related to plasmonic physics and devices.

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