Dipolar Model Analysis for Large Array of Plasmonic Elements and Molecular Aggregates

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In this work we present a powerful approach based on dipolar model analysis for solving large array of plasmonic elements on layered substrates. It is known solving a plasmonic element is a numerically complex task due to the large negative permittivity value. Now imagine one will have an array of 100x100 of such elements and on a layered substrate (and not necessarily periodic). This will be a very complicated task (if not impossible) to manage. Due to the subwavelength size of the particles one can approximate them though with dipolar modes. Then the problem will be reduced to large array of dipoles on a layered substrate, Sommerfeld type integrals. We will then apply complex image method to take the effect of substrate with few complex image points and manage the problem successfully. We will be able to solve very large complex plasmonic elements and for applications in various disciplines including energy-engineered materials in nanoscale and metasurfaces. The model can be also applied to understand the physics of molecular aggregates such as chlorophyll bacteria structures made from millions of molecules.

We will also apply our technique to more complex building block structures (not just spherical particles). Using the quasistatic approximation, the scattering performance and extinction coefficients of a single building block will be obtained by numerically solving Poisson's equation from which the polarization factor for the block can be obtained. This technique extends the range of applicability of dipolar model analysis for the case of large arrays of arbitrary shaped particles on layered substrates. The method is fast and efficient and is therefore suitable for numerical optimization of plasmonic arrays field performance. The model and novel results in the area of metamaterials will be presented.