Model for the BRDF of disordered metasurfaces

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We review our current efforts to model the bidirectional reflectance distribution function (BRDF) of disordered metasurfaces and demonstrate novel visual properties not found in biodiversity with low-index nanostructures.

Introduction

Disordered metasurfaces, comprising non-periodic arrangements of meta-atoms, present an untapped potential for tailoring light scattering properties [1-2]. These metasurfaces offer many degrees of freedom. Quantitatively predicting the visual appearance of metasurfaces requires advanced knowledge of the nanoscale resonances, mesoscale interferences and macroscale light transport to compute the bidirectional reflectance distribution function (BRDF). We review our current efforts to model the BRDF of disordered metasurfaces, emphasizing metasurfaces with particulate morphologies, where well-identified individual metaatoms are arranged in deterministic or random patterns.

The numerical tools

Approximate models are required. We have now implemented two generations of models.

First generation tool. In [3], we reported the very first simulation tools to study the appearance of disordered metasurfaces. The tool predicts subtle effects not covered by earlier works on structural colors. For instance, it predicts a striking iridescence that appears when a short-range amorphous correlation is introduced in a monolayer of silver nanospheres that look grey without correlation [4], see Fig. 1 and the Supplementary Videos 1 & 2 in [3].

Second generation tool. Recently, we improved the first-generation tool and proposed an interpretive, intuitive and accurate modal-based tool that unveils the main physical mechanisms impacting the color and visual appearance of complex metasurfaces [4].

Third generation tool. In our recent work, we are developing full wave tool based on supercell approaches [4].

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