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Johansen, Villads Egede; Sigmund, Ole

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Villads Egede Johansen[a,b], *Ole Sigmund*[a]

[a]Department of Mechanical Engineering, Technical University of Denmark, Nils Koppels Allé 404, 2800 Kongens Lyngby, Denmark

[b] vejo@mek.dtu.dk

Colors reflected from surfaces are caused by either the absorptive properties of materials and/or light's interaction with structures having dimensions comparable to the wavelength of light (nm range). The interaction with structures is what is referred to as structural coloration, and is the effect seen when looking at CDs, peacock feathers and many other natural and man-made objects. In recent years more and more efforts have been made in investigating and analyzing these structures, Vukusic and Sambles (2003); Kinoshita and Yoshioka (2005); Saito (2011), but little effort has been devoted to trying to create new colors and color effects by designing nanostructures (examples of existing designs are multilayer coatings, diffraction gratings and interferometric modulator displays). Applications for structural coloring include altering the color of certain products even though they are made of the same material by e.g. only changing the casting mold (LEGO brick coloration, pre-printed text), new color appearances for product design, extremely durable colors, improved optical materials (anti-reflective surfaces, color filters) and more eco-friendly production processes due to the saving of paint.

Optimizing for color differs from most other structural optimization problems in the way that the objective is more subjective: Comparing two colors and determining which matches the desired color best can give ambiguous results depending on the observer, several light spectra can yield the same color, and the overall perception of color is determined in relation to the surroundings of an object.

The overall goal is to explore the possibilities and limitations of altering the structure of a surface on nanoscale to present a desired color effect, and this study can be seen – together with Friis and Sigmund (2012) – as a part of the foundation for achieving this goal. Based on a simple implementation of the physics called Scalar Diffraction Theory, Goodman (1996); O'Shea (2004), color responses and analytical gradients are calculated for the optimization problem. Using this setup we present optimized surfaces with different color effects designed only by changing the profile of the surface.

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