Universal Imprinting Of Chirality With Chiral Light By Employing Plasmonic Metastructures

Oscar Avalos-Ovando[1]

[1]Ohio University, Athens, Ohio, United States

Abstract

Chirality, either of light or matter, has proved to be very practical in biosensing and nanophotonics [1]. However, the fundamental understanding of its temporal dynamics still needs to be discovered. A realistic setup for this are the so-called metastructures, since they are optically active and are built massively, hence rendering an immediate potential candidate. Here, we propose and study the electromagnetic optical mechanism leading to chiral optical imprinting on metastructures [2].
Metastructures are modeled in Comsol Multiphysics within the RF module, using a symmetric mesh approach in order to avoid artifact chiral responses. We simulate illumination with linearly polarized light or circularly polarized light under two different regimes, either the static continuous wave or the temporal pulsed excitation, and calculate the photothermal response of the system. Changes in temperature will affect the material's permittivity at different times, in the so-called symmetry-breaking window, creating anisotropic permittivity patterns, before reaching thermal relaxation. This occurs differently for left or right circularly polarized light, leading to temporal-dependent chiral imprinting of hot-spots, namely, "imprinting of chirality." The above effect has just been observed simultaneously with our study [3], hence it is within reach of modern experimental approaches. The proposed nonlinear chiroptical effect is general and should appear in any anisotropic material; however, we need to design a particular geometry for this effect to be strong. These new chiral time-dependent metastructures may lead to a plethora of applications.

Reference

[1] O. Avalos-Ovando et al, "Chiral bio-inspired plasmonics: a paradigm shift for optical activity and photochemistry", ACS Photonics 9, 2219 (2022).
[2] O. Avalos-Ovando et al, "Universal imprinting of chirality with chiral light by employing plasmonic metastructures", Appl. Phys. Rev. 10, 031412 (2023).
[3] Andrew S. Kim et al, "Phototransformation of achiral metasurfaces into handedness-selectable transient chiral media", PNAS 121, e2318713121 (2024).

Figures used in the abstract

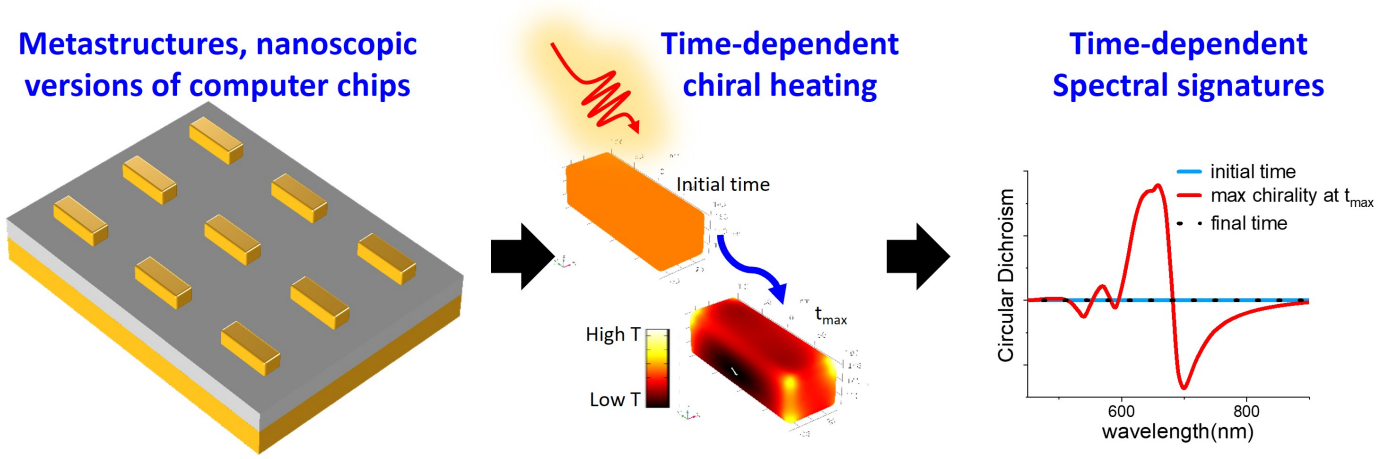
Metastructures, nanoscopic versions of computer chips
Time-dependent chiral heating
Time-dependent Spectral signatures
Initial time
High T
Low T
t_{max}
initial time
max chirality at t_{max}
final time
Circular Dichroism
600
800
wavelength(nm)

Figure 1