Femtosecond switch - switchable chirality and thus switchable optical activity in metamaterials

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Using an optical or electrical signal to change the chirality and therefore the optical activity in either the visible, infrared or THz spectrum for a certain wavelength: This is possible with the new switch based on plasmonic resonance in metamaterials.

- Simple and fast inversion of handedness – reversibly switchable
- Wavelength tunable
- Strength of the circular dichroism signals freely adjustable for both switching levels
- Switchable in the pico- or femtosecond range
- Flexible tuning over a wide frequency range – infrared, visible and THz range
- Simple production based on well-known and validated processes

Fields of application

The inventive metamaterial opens up new possibilities e.g. for stereo imaging, in particular 3D imaging, VR/ AR glasses, thermal imaging, nanophotonic circuits and data storage.

Background

The present invention offers the possibility to switch the optical activity of a chiral metamaterial reversibly so that the invented system can switch between levorotary and dextrorotary.

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TRL4 - Validation

Patent Situation

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14/101TLB

Service

Technologie-Lizenz-Büro GmbH has been entrusted with exploiting this technology and assisting companies in obtaining licenses.

Problem

There are several approaches focusing on the creation of metamaterials with switchable chirality. However, these solutions are expensive, difficult to produce and slow in terms of switching time. In addition, metamaterial properties can only be adjusted to a specific wavelength range to a limited extent – if at all.

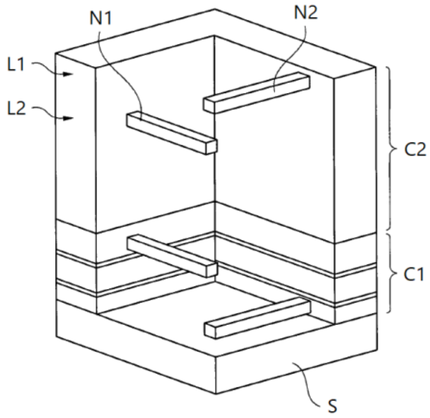
Solution

Funded by the Baden-Württemberg Stitftung gGmbH, the University of Stuttgart has now developed a metamaterial switch with a chirality that can be switched within pico- or even femtoseconds. By changing the chirality, the optical activity is changed completely from levorotary to dextrorotary or vice versa.

The wavelength range, in which the system operates, can be flexibly adjusted through the geometry of the nanostructures and the choice of the phase change material that is used as switching material. The Invention can therefore be used for the visible as well as IR range.

Switchability of the chirality is realized by combining an active chiral metamaterial (which uses the phase change material GST-326 as switching material) with a passive chiral metamaterial. In addition, the strength of the circular dichroism signals can freely be adjusted.

The switching process is triggered by an optically or electrically excited phase change of the switching material in the active metamaterial. The circular dichroism signal is switched between 100 % and 0 % at the peak wavelength of plasmonic resonance.



Principle sketch of the novel switch with 2 chiral arrangements C1 and C2 and therein contained nanostructures N1 and N2 on 2 different levels L1 and L2 each [Figure: University of Stuttgart].

Publikationen und Verweise

„Active Chiral Plasmonics“, Xinghui Yin, Martin Schäferling, Ann-Katrin U. Michel, Andreas Tittl, Matthias Wuttig, Thomas Taubner, and Harald Giessen,

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Additional background information in:

"Interpreting Chiral Nanophotonic Spectra: The Plasmonic Born–Kuhn Model",
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Nano Letters 2013 13 (12), 6238-6243,
https://doi.org/10.1021/nl403705k