Switchable optical spectrum through plasmonic nano-antennas made of yttrium dihydride / yttrium trihydride

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Plasmonic nano-antenna made of Yttrium dihydride have optical properties, that can be changed reversely by adding hydrogen without being sensitive to temperature changes. Since they can be produced with tested processes, there several fields of application.

- Adding hydrogen for switching the antenna
- Reversibly switchable
- The optical spectrum be adapted through the geometry of the antenna
- High optical contrast through high change of the optical spectrum
- Use independent of ambient conditions at different temperature ranges
- Long service life, wear and age-free
- Production based on tried and tested processes

Fields of application

Nano-optical switching elements can be used in a variety of ways. The possible fields of application of the yttrium nano antennas according to the invention range from switchable optical filters (filter for glasses) to optical switching elements for e.g. waveplates, phase shifters, modulators and absorbers. Additional fields of application include the use as hydrogen sensors or the local control of chemical reactions.

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Development Status
TRL4 - Validation

Patent Situation
DE 102014203488 B4 granted

Reference ID
13/093TLB

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

Background

Previous approaches to make optical properties switchable include optical filters or absorbers that are mechanically switched (e.g. rotatable interference filters, stretch films). However, the mechanical switching leads to wear and tear and thus to a reduction in service life.

Problem

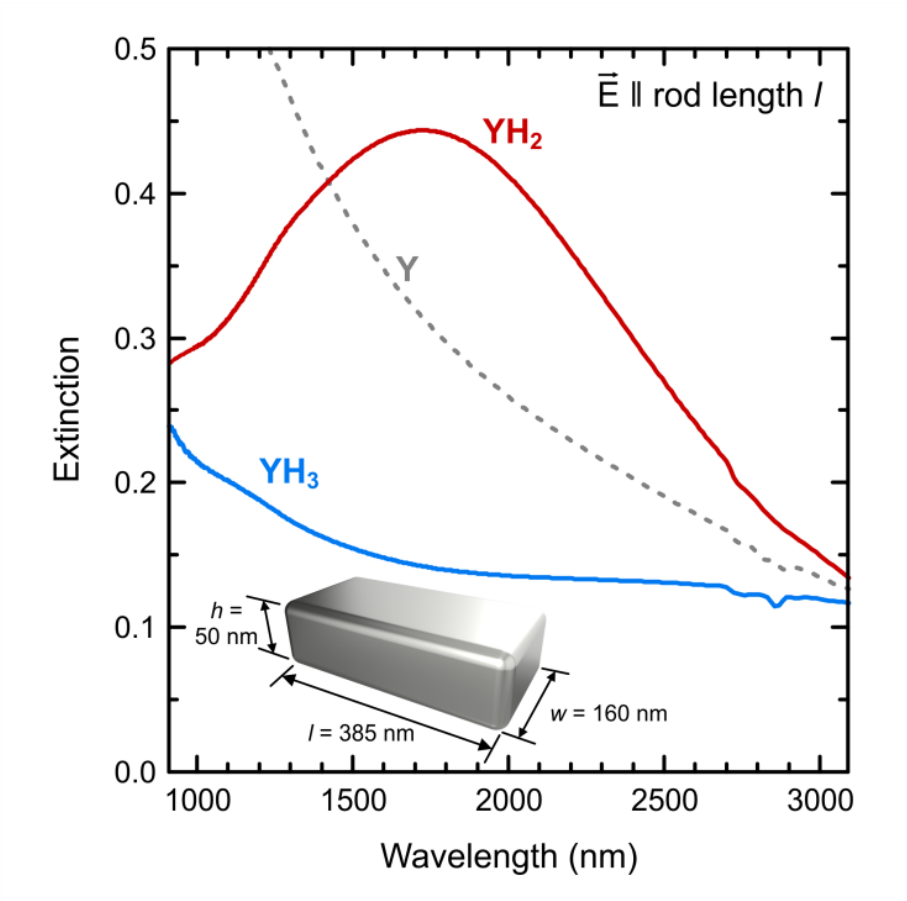
Phase change materials are already being used in combination with high quality plasmon antennas. Here, the plasmonic response of the nano antennas is controlled by changing the dielectric environment, but the optical contrast between the switchable states is very weak. Other phase change materials such as vanadium oxide (VO_2) can be used as plasmonic nano antennas. However, besides having very poor optical properties, they can only be used within a very limited temperature range.

Solution

In a project funded by the Baden-Württemberg Stiftung gGmbH, scientists at the University of Stuttgart have now developed a reversibly switchable nanostructure that can be easily switched from a metallic, plasmonically active to a non-metallic, plasmonically inactive state.

The researchers demonstrated that nanostructures made of yttrium dihydride (YH_2) exhibit plasmonic resonances, whereby the optical spectrum depends on the geometry of the antenna. They also showed that these nanostructures can be easily and reversibly hydrogenated into yttrium trihydride (YH_3), which does not show a plasmonic resonance. Switching between the two hydrogenation states can be done by simply switching the hydrogen supply on and off, since YH_3 is formed from YH_2 by supplying hydrogen and dehydrates to YH_2 as soon as the hydrogen supply is switched off.

The atomic hydrogen can either be supplied from the outside or by applying a voltage to an electrochemical source, which makes it possible to use it for example as a filter for glasses.



Extinction spectrum of a yttrium, YH2 and YH3 nano antenna [Image: University of Stuttgart].