Spin Hall effect of light achieved with near 100% efficiency

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A POSTECH-KAIST joint research team has successfully developed a technique to reach near-unity efficiency of SHEL by using an artificially-designed metasurface.

Professor Junsuk Rho of POSTECH's departments of mechanical engineering and chemical engineering, and Ph.D. candidate Minkyung Kim and Dr. Dasol Lee of Department of Mechanical Engineering in collaboration with Professor Bumki Min and Hyukjoon Cho of the

Department of Mechanical Engineering at KAIST have together proposed a technique to enhance the SHEL with near 100% efficiency using an anisotropic metasurface. For this, the joint research team designed a metasurface that transmits most light of one polarization and reflects the light from the other, verifying that the SHEL occurs in high-frequency region. These research findings were recently published in the February issue of Laser and Photonics Reviews, an authoritative journal in optics.

The spin Hall effect of light (SHEL) refers to a transverse and spin-dependent shift of light to the plane of incidence when it is reflected or refracted at an optical interface. When amplified, it can shift light that is several times or tens of times greater than its wavelength.

Previous studies of enhancing the SHEL have involved greater light movement with little consideration for efficiency. Since enhancing the SHEL produces extremely low efficiency, studies on achieving a large SHEL and high efficiency simultaneously have never been reported.

To this, the joint research team used an anisotropic metasurface to enhance the SHEL. It was designed to enable high SHEL by transmitting most of the light from one polarization while reflecting the light from the other. By measuring the transmission of metasurface in the high-frequency region—such as microwaves—and verifying the polarization state of the transmitted light, the researchers verified the occurrence of SHEL reaching 100% efficiency.

"The very mechanisms that enhance the SHEL in most previous studies in fact lowered its efficiency," remarked Professor Junsuk Rho, the corresponding author who led the study. "This research is significant in that it is the first study to propose a method to calculate the efficiency of the SHEL, and to increase its efficiency and enhance the SHEL simultaneously." He added, "The SHEL is applicable in microscopic

optical devices, such as beam splitters, filters and switches, and this study will improve their effectiveness."

More information: Minkyung Kim et al, Spin Hall Effect of Light with Near-Unity Efficiency in the Microwave, *Laser & Photonics Reviews* (2020). DOI: 10.1002/lpor.202000393

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