Technology Offer

Precise LIDAR Devices: Metasurface for Large-Angle Beam Steering

Ref.-No.: 1201-6235-BC

The invention relates to a new device for precise large-angle beam steering at an extended wavelength range. It is based on an electrically-controlled metasurface and allows for the implementation in advanced LIDAR systems.

Metasurfaces are used to change properties of light and can therefore be used to steer an incoming beam. However, common devices are lacking spatial resolution and are thus limited to small angles. Furthermore, state-of-the-art metasurfaces for respective applications can only be used for IR light and at low intensities.

By using a compact design and different materials, the new pixel-level electrically controlled metasurface provides a large range of angles as well as broadband applicability. These properties allow for the use in an enhanced beam steering device for precise LIDAR systems.

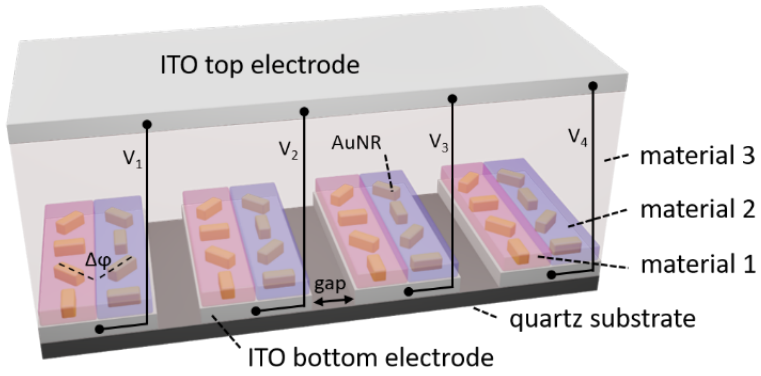

Fig. 1: Schematic 3D view of the electrically-controlled metasurface for beam steering. The indium tin oxide bottom electrodes (light grey) are individually addressed by potentials V_1 to V_i (only i up to 4 is shown).

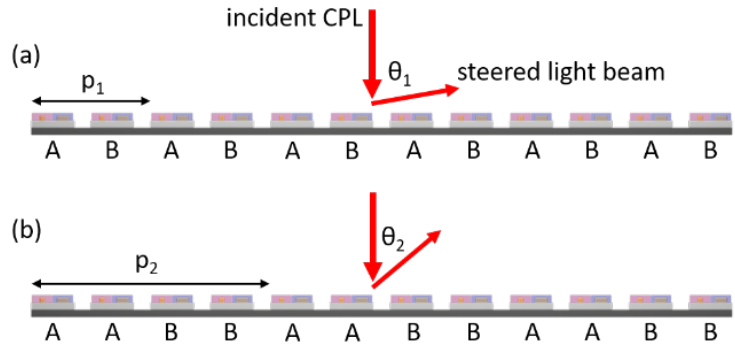

Fig. 2: Illustration of the beam steering mechanism. By addressing each of the electrodes individually with a pattern of periodicity p_i, the incoming beam can be steered to an angle θ_i due to interference.

Advantages

- Large steering angle range
- Operation beyond infrared possible
- Quasi-continuous spatial frequency patterns
- Design easily adoptable for other wavelengths

Applications

- Beam steering
- LIDAR

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Background

Metasurfaces are a promising class of optical components with a growing field of applications. However, beam steering with a metasurface remains challenging and limits the applicability for devices like LIDAR systems. State-of the art metasurfaces cannot cover a large range of steering angles and are typically limited to IR light with the requirement of specifically chosen wavelengths and thus limited flexibility.

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A novel electrically-controllable dynamic metasurface has been developed to overcome the aforementioned shortcomings that allows the use in large angle beam steering applications like LIDAR. It is based on the amplitude modulation with adjustable spatial patterns.
A metasurface according to the invention (cf. fig. 1) comprises multiple rows of gold nanorods (AuNRs), which are grouped in pairs on top of ITO bottom electrodes. Of the two sub-rows, one is coated with an active material that changes its refractive index upon changes of the potential *V*, while the other remains constant. Therefore, the different potentials V_i control the reflected amplitudes of the rows *i* and the surface can thus be used as an optical grating with adjustable spatial frequency. Different spatial frequencies correspond to different diffraction angles and the maximum steering angle results from the highest periodicity. Hence, a metasurface corresponding to the invention can achieve remarkably wide angles due to its high resolution.
If used together with a pulsed laser, the steered light beam can be used in a LIDAR system (cf. fig. 3). Reflected light can be detected by a photo-detector and from the propagation time, an objects distance can be calculated. As a light scanning unit, the incident time-triggered pulses are steered across a range of angles without the need of mechanically moving parts.

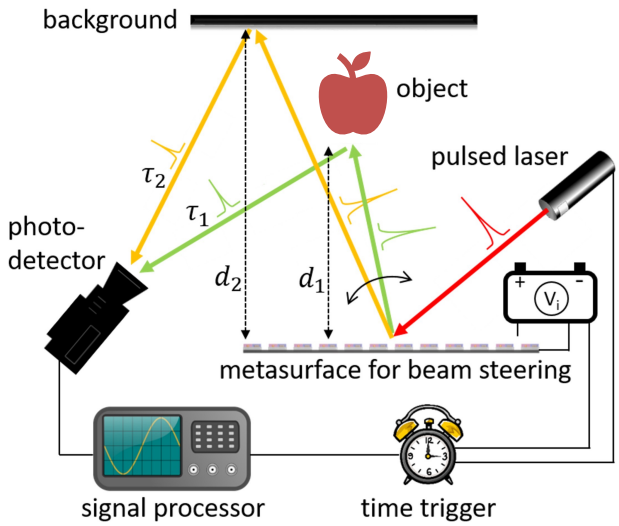

Fig. 3 Schematic illustration of a LIDAR system, which uses the metasurface for beam. A time triggered laser pulse is scanned across a one-dimensional angle range by the voltage controller of the metasurface. Time-of-flight measurements of the light are used to reveal an objects distance.

Patent Information

PCT *(Application filed)*, EP

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