Efficient polarization beam splitter pixels based on a dielectric metasurface: supplementary material

M. KHORASANINEJAD,^{1*} W. ZHU,¹ K. B. CROZIER,^{1,2,3*}

¹School of Engineering and Applied Sciences, Harvard University, 33 Oxford Street, Cambridge, MA 02138, USA

²Department of Electrical and Electronic Engineering, University of Melbourne, Victoria 3010, Australia

³School of Physics, University of Melbourne, Victoria 3010, Australia

*Corresponding authors: khorasani@seas.harvard.edu and kcrozier@unimelb.edu.au

Published 15 April 2015

This document provides supplementary information to "Efficient polarization beam splitter pixels based on a dielectric metasurface," <http://dx.doi.org/10.1364/optica.2.000376>. © 2015 Optical Society of America

<http://dx.doi.org/10.1364/optica.2.000376.s001>

1. Scanning Electron Micrographs of Single Nanoridges

Scanning electron micrographs (SEMs) of successively rotated nanoridges are shown in Fig. S1. All nanoridges have widths $W=60$ nm, lengths $L=5$ μm and heights $H=500$ nm. Nanoridges successively rotate by 45 degree and are spaced by 5 μm (center-to-center).

2. Measurement Set-up

Figure S2 shows the measurement set-up. The set-up is a homebuilt optical microscope with an infrared-LED (IR-LED) as the light source. The output of the LED is collected by a condenser and passes through a linear polarizer, and illuminates the pixel-integrated polarization splitter (PIXIP) sample. Light transmitted through the sample is collected by a microscope objective lens. The latter, in combination with a tube lens (focal length $f = 15$ mm), forms an image on an infrared camera.

3. Asymmetric Deflection

One-sided deflection is realized using a unit cell comprising eleven nanoridges whose widths W linearly increase from 40 nm to 90 nm, from left to right (Fig. S3). The different phase delays that the nanoridges generate (owing to their different widths) result in the output comprising a tilted wavefront. The nanoridges have center-to-center distance $P=500$ nm and heights $H=2$ μm , and simulations are performed at $\lambda=950$ nm. While input light polarized parallel to the nanoridges is deflected to the right side (Fig. S3, top), light polarized perpendicular to the ridges mainly remains undeflected (Fig. S3, bottom).

Fig. S1. Top: Top-view SEM of successively rotated single nanoridges, scale bar is 2 μm . Bottom: Tilted-view SEM of nanoridges, scale bar is 400 nm.

Fig. S2. Experimental set-up consisting of an LED ($\lambda=940$ nm) whose output is collected by a condenser and passes through a linear polarizer (LP). An objective lens (N.A.:0.55, magnification: 50 $\times$), a tube lens, and a camera are used to capture images.

Fig. S3. Simulated power flow for light polarized parallel (top) and perpendicular (bottom) to length of nanoridges. Wavelength of operation is $\lambda=950$ nm. There are eleven nanoridges with heights $H=2$ μm and center-to-center distances $P=500$ nm. Width of far-left nanoridge is $W=40$ nm and the width increases in a linear fashion ($\Delta W=5$ nm) to $W=90$ nm for far-right nanoridge.

Fig. S4. Measured intensity distributions of PIXIP device (imaging plane is 15 μm from substrate) showing PIXIP device steers impinging light. Top: input light is x-polarized. Bottom: input light is y-polarized.

4. Intensity Distributions from PIXIP Device

In Fig. S4, measured intensity distributions of region of PIXIP device containing 10 $\times$ 10 pixels (5 $\times$ 5 unit cells) are shown for input light having x- (top figure) and y-polarizations (bottom figure), respectively.

5. Evolution of Intensity Distribution as Input Polarization Changes

In Fig. S5, the measured intensity distribution for one unit cells of the PIXIP device is shown for different choices of input polarization angle (0 to 90 $^\circ$). Figure 5 of the main manuscript was generated by analysis of this data.

Fig. S5. Evolution of intensity distribution of one unit cell of PIXIP device when polarization is gradually changed from 0 to 90°. Polarization angle (in degrees) is noted at top of each image.