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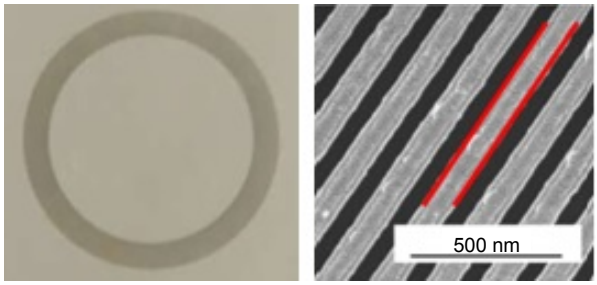
Design of sub-wavelength radially polarized grating

Qiao Tan[1, 2*], Qifeng Xu[1] and Nan Xie[1]

[1]College of Electric Engineering and Automation, Fuzhou University, Fuzhou 350108, China; [2]Department of Electronic Engineering, Fujian Polytechnic of Information Technology, Fuzhou 350012, China



The entity and image of electron microscope scanning of grating.

Abstract: To solve the problems of nonlinear measurement of Faraday rotation existing in the power optical sensing, a new type of circular polarization grating is designed, in which the grating grooves are arranged along the radial direction in a ring. For the polarization grating, the TE wave (parallel to the grooves) has a high reflection and the TM wave (perpendicular to the grooves) has a high transmission. Therefore, according to the Malus' law, when a linearly polarized light is transmitted through the grating, the output light gets the maximum and minimum intensities at the directions perpendicular and parallel to the polarization direction of the LP light, respectively. Because the grating is ring-shaped and the average space between adjacent grooves is in nanometer size, a linearly polarized light with any polarization direction can generate a ring-shaped intensity distribution image with dark and bright stripes after passing through the grating. In brief, the grating can be described as a radial polarizer in which the transmission axis is perpendicular to the azimuth angle that can be varied within 0~360 degree. When the azimuth angle changes, the intensity distribution will rotate accordingly, and its rotation angle is equal to the azimuth angle. Therefore, the polarization rotation can be linearly measured by detecting the rotation of the dark stripe center.

The theory of polarization detection is analyzed by using Jones matrix, and the output facula images in different azimuth angles of the linearly polarized light are given in the paper. The parameters of the grating are simulated by rigorous coupled wave theory, including the transmittance and extinction ratio under different depths, different periods and different duty radios, and then all the grating parameters are determined. The material of the grating is selected as aluminum, the width of the grooves is 50 nm, the depth is 100 nm, the inner and outer radii are 8 mm and 10 mm, respectively, the period and the duty cycle in the inner radius are 100 nm and 0.5, and the period and the duty cycle in the outer radius are 200 nm and 0.25. The polarization grating is manufactured by electron beam lithography, nanometer imprinting and plasma etching technologies.

Finally, the performances of the grating are tested. When the wavelength of light varies from 600 nm to 1600 nm, the TM transmittance of the grating is greater than 80%, and the extinction ratio is greater than 100. What's more, when the incident azimuth angle changes, the output facula image detected by the grating rotates synchronously with the angle.

In a word, the new designed grating has the advantages of large linear measurement range and measurement results independent on the absolute intensity, so that it will form a new detection technology of polarization based on the image method.

Keywords: grating; sub-wavelength metal grating; radially polarized light; polarization detection

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