Engineering nano-gratings on cylindrical surfaces using ultrasonic elliptical vibration texturing for novel realization of dynamic color image display

Yang Yang[1, #] and Kang Wu[1]

1 School of Mechanical Engineering and Automation, Harbin Institute of Technology (Shenzhen), Shenzhen 518055, China
Corresponding Author / Email: yangyang2020@hit.edu.cn.

KEYWORDS: Dynamic color image display, Nano-grating, Cylindrical surface, Elliptical vibration texturing

Structural color based on engineered nanostructures are of great interest in recent years due to its unprecedented high-resolution and high-density information encryption. So far, most of the research has been dedicated to the static structural color on planar surfaces, limiting its full potential in many potential applications. In this paper, a novel dynamic color image display method is demonstrated, for the first time, by tailoring the grating diffraction between the incident parallel white light and nano-gratings on cylindrical metallic surfaces. Controllable nano-gratings are fabricated using ultrasonic elliptical vibration texturing in the standard turning operation. Building on the insights gained from the grating diffraction theory, multi-frames iridescent color images are achieved by cooperatively varying the spacing distances and circumferential positions of the nano-gratings on cylindrical surfaces. An innovative process parameter planning algorithm is then proposed to relate the turning process to the global image rendering performance. Different images will be selectively displayed depending on the viewing angle to realize the dynamic image display or animation. Using this rendering strategy, we demonstrate the dynamic image display with structural colors purely by encoding multi-frame images with spatially separated diffractive spectrum. The overall rendering performances of dynamic color image display is quantitatively evaluated by comparing the real-time cutting process parameters to the designed ones and measuring the similarity between the reproduced and original image at each designed frame. The proposed novel engineering method for dynamic color image display will find a wide array of applications in information storage, cryptography and anti-counterfeiting.