Fabrication and Alignment of Hybrid Gratings for Absolute Measurements

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Hybrid gratings play a crucial role in absolute measurements. These hybrid gratings comprise two functional regions: a measurement grating area for obtaining displacement and an absolute codes area for zero position determination, enabling absolute measurement. The inclusion of absolute codes ensures that errors in each measurement region are independent, thereby enhancing measurement accuracy. The fabrication quality of hybrid gratings is a critical factor influencing the precision of grating-based measurement systems. Due to the differences in linewidth requirements between the 2D (2-dimension) grating and absolute codes, the 2D grating is optimally fabricated using holographic lithography, while absolute codes are more suitable for masked lithography. Achieving precise alignment between these two regions is a significant technical challenge.

In this paper, we present a novel fabrication process for hybrid gratings that integrates holographic lithography and masked lithography within a unified optical path. This process incorporates advanced alignment techniques to ensure accurate positioning of the two distinct patterned regions. The alignment signal is generated from the diffraction of a reference grating, which is integrated into the mask for fabricating the absolute code. This reference grating, placed within the interference optical path, produces reference fringes recorded by a CCD camera. By analyzing and precisely adjusting these reference fringes, the alignment between the grating and absolute codes regions is optimized, thereby significantly reducing measurement errors caused by alignment inaccuracies. This methodology enhances the overall performance and precision of the hybrid grating measurement system and it will provide new ideas for the measurement of absolute multi-degree of freedom grating encoders.

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