光学精密工程 » 2015, **Vol. 23** » Issue (12): 3335-3342 DOI: 10.3788/OPE.20152312.3335

基于闪耀光栅图形化实现高分辨率干涉光刻

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High resolution pattern-integrated interference lithography based on blazed grating

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摘要 图/表 参考文献 相关文章 (15)

全文: PDF (1633 KB) RICH HTML NEW

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摘要 为提高图形化干涉光刻质量,提出了基于闪耀光栅的图形化干涉光刻(PIIL)系统, 并对该系统所采用的光学原理和实现方法进行了研究。首先,分析了图形化干涉光刻系统的光场特性,阐述了其分辨率提升的原理。讨论了光学系统带宽和图案分布对光刻图形质量的影响,给出了图形质量控制的工艺方法。其次,提出了一种新型的图形化干涉光刻方法,该方法采用闪耀光栅作为衍射分光器件,实现了位相和振幅的一体化调制。采用数值计算方法模拟了闪耀光栅的衍射特性和像面光场分布,讨论了闪耀光栅的优化设计方法,获得了高达92.3%的±1级衍射效率。最后,基于数字微镜器件(DMD)和微缩成像光路设计开发了图形化干涉光刻系统,实验获得了像素化的点阵图形和质量明显改善的光刻图像,验证了该方法对任意图形的适用性。

关键词 : 图形化干涉光刻, 傅里叶光学, 衍射效率, 激光直写, 数字微镜器件

Abstract : To improve the quality of pattern interference lithography, a Pattern-integrated Interference Lithographic(PIIL) system based on a blazed grating was proposed, and the theory of optical system and the method to realize a high quality pattern were investigated. Firstly, the optical field properties of the typical PIIL system were analyzed and how to improve the resolution of the system was described. The influences of the system bandwidth and the pattern feature on the image quality were discussed and the process technique to enhance the pattern uniformity in the interference exposure was given. Then, a novel pattern-integrated interference lithographic method was proposed. The blaze grating was used as a diffraction beam splitter to realize the integration of phase and amplitude modulation and the numerical calculation was used to simulate the diffraction properties of the blazed grating and the optical field distribution on an image plane. The parameter optimization of the blazed grating was discussed and the diffraction efficiency up to 92.3% was obtained for ±1 order. Finally, the pattern-integrated interference exposure system was presented based on a Digital Mirror Device(DMD), a micro imaging path and the patterns of pixelated dot-matrix were obtained and the quality of pattern of interference lithography was improved markedly. The results verify the applicability of the method for arbitrary structures.

Key words : pattern-integrated interference lithography Fourier optics diffraction efficiency laser direct writing Digital Mirror Device(DMD)

中图分类号: TN305.7

O436.1

基金资助:国家自然科学基金重大研究计划资助项目(No.91323303)

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引用本文:

胡进, 董晓轩, 浦东林, 申溯, 陈林森. 基于闪耀光栅图形化实现高分辨率干涉光刻[J]. 光学精密工程, 2015, 23(12): 3335-3342. HU Jin, DONG Xiao-xuan, PU Dong-lin, SHEN Su, CHEN Lin-sen. High resolution pattern-integrated interference lithography based on blazed grating. Editorial Office of Optics and Precision Engineering, 2015, 23(12): 3335-3342.

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