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现代应用光学

闪耀全息光栅离子束刻蚀工艺模拟及实验验证

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摘要： 依据特征曲线法推导了非晶体表面的离子束刻蚀模拟方程,结合全息光栅的刻蚀特点开发出离子束刻蚀模拟程序,并通过实验数据分析并优化了非晶体材料刻蚀速率与离子束入射角的关系方程,最后利用离子束刻蚀实验对所开发的离子束刻蚀模拟程序进行了实验验证。调节掩模与基底材料的刻蚀速率比为2：1至1：2,制作了线密度为1 200 l/mm,闪耀角为~8.6°,非闪耀角为34°~98°的4种闪耀光栅,与刻蚀模拟程序的结果进行对比,模拟误差<5%;控制离子束刻蚀时间为6~14 min,制作了线密度为1 200 l/mm,闪耀角为~8.6°,顶角平台横向尺寸为0~211 nm的6种光栅,与刻蚀模拟程序的模拟结果进行对比,模拟误差<1%。比较实验及离子束刻蚀模拟结果表明,离子束刻蚀模拟程序获得的模拟刻蚀轮廓曲线与实际刻蚀轮廓曲线的误差<5%;模拟刻蚀截止点与实际刻蚀截止点误差<1%。实验表明,提出的模拟方程可以准确地描述不同工艺过程和工艺参数对最终刻蚀结果的影响,进而可预知和控制离子束刻蚀过程。

关键词： 闪耀光栅 全息光栅 衍射效率 刻蚀模拟 离子束刻蚀

Simulation and experiments of ion beam etching process for blazed holographic grating

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Abstract: A simulation equation of surface etching for amorphous materials during ion beam etching was worked out based on the characteristic curve method, and a simulation program named BLAZING for the ion etching process was established according to the holographic grating.Then, the relation between the etching rate of amorphous materials and ion beam incidence was analyzed and optimized. Finally, an experiment was carried out to verify the simulation program with the ion beam etching. By adjusting the etching rate ratio from 2：1 to 1：2 for a mask and substrate materials, four 1 200 l/mm blazed gratings with the right angle between 34° and 98° and the blazed angle about 8.6° were fabricated, and the simulation error between the experimental data and the simulation data is less than 5%. By controlling the etching time from 6 min to 14 min, six 1 200 l/mm blazed gratings with the ridge between 0 nm and 211 nm and the same blazed angle of 8.6° were fabricated, and the error mentioned above is less than 1%. The contrast results illustrate that the error of contour line between simulation and experimentation is less than 5%, and the error of etching ending time between simulation and experimentation is less than 1%. It concludes that the simulation program BLAZING can simulate the effect of different etching processes and different parameters on the etching results, and can predict and control the ion beam etching process.

Keywords: blazed grating holographic grating diffraction efficiency, etching simulation ion beam etching

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