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激光材料和光学元件

离子束溅射、热舟和电子束法制备深紫外LaF_3薄膜

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摘要:

为了满足深紫外光刻物镜对薄膜的要求,得到低损耗、高稳定性、长寿命的深紫外薄膜,需要选用适当的镀膜工艺方法。分别选取了离子束溅射法、热舟蒸发法和电子束蒸发法优化后的最佳工艺参量,在融石英基底上使用3种方法镀制了单层LaF_3薄膜。首先,利用光度法得出3种方法镀制LaF_3薄膜在185nm~800nm范围内的折射率n和消光系数k。然后,采用原子力显微镜对薄膜表面粗糙度进行了测量。最后,薄膜的微结构使用X射线衍射仪进行了分析。结果表明,离子束溅射镀制的LaF_3薄膜折射率最高、表面粗糙度最低,但吸收较大;电子束蒸发法虽然吸收最小,但是折射率偏低且表面粗糙度较高;热舟蒸发法镀制的LaF_3薄膜无论折射率、消光系数还是表面粗糙度都处于3种方法中间位置。综合各项指标,热舟蒸发法最适合于沉积深紫外LaF_3薄膜。

关键词: 薄膜 LaF_3 热蒸发 离子束溅射 深紫外

DUV LaF_3 thin film deposited by IBS, thermal boat and electron beam evaporation

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Abstract:

In order to satisfy the requirements of coatings of deep ultraviolet(DUV) lithography objective lens and obtain coatings with low optical losses, high stability and long lifetimes, a deposition method should be confirmed first. LaF_3 single layers were deposited upon fused silica by ion beam sputtering(IBS), boat and electron beam evaporation with optimized process parameters respectively. Firstly, based on spectrophotometry, the refractive index n and extinction coefficients k in 185nm~800nm of the LaF_3 layer deposited with three methods were obtained. Secondly, the surface roughness of LaF_3 layers was measured by means of atomic-force microscope(AFM). Finally, X-ray diffraction(XRD) was used to investigate the microstructure of LaF_3 layer. Experimental results indicate that, LaF_3 layer deposited by IBS has the highest refractive index and the lowest surface roughness but the highest extinction coefficients; for LaF_3 layer deposited by electron beam, although its extinction coefficients is low, but the refractive index and surface roughness doesn't seem good; as for thermal boat, all parameters discussed here is intermediate between that of LaF_3 layer deposited by IBS and electron beam. Finally,based on consideration with every factors, thermal boat evaporation method is most suitable for depositing DUV LaF_3 film.

Keywords: thin films LaF_3 thermal evaporation ion beam sputtering deep UV

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