

摘要: 基于正交试验方法, 系统研究了用离子束溅射法制备SiO₂薄膜其折射率、应力与工艺参数(基板温度、离子束压、离子束流和氧气流量)之间的关联性。使用分光光度计和椭圆偏振仪测量SiO₂薄膜透射光谱和反射椭圆特性, 利用全光谱反演算法获得薄膜的折射率, 通过测量基底镀膜前后的表面变形量得到SiO₂薄膜的应力。实验结果表明, 工艺参数对薄膜折射率影响权重从大到小依次为氧气流量、基板温度、离子束流和离子束压, 前三者对折射率影响的置信概率分别为87.03%、71.98%和69.53%; 对SiO₂薄膜应力影响权重从大到小依次为基板温度、离子束压、氧气流量和离子束流, 前三者对应力影响的置信概率分别为95.62%、48.49%和37.88%。得到的结果表明, 制备低折射率SiO₂薄膜应选择高氧气流量、低基板温度和低离子束流; 制备低应力SiO₂薄膜应选择低基板温度和高氧气流量。

关键词: SiO₂薄膜 正交实验 折射率 应力 离子束溅射

Adjustments of refractive index and stress of SiO₂ films prepared by IBS technology

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Abstract: The effects of preparative parameters such as substrate temperature, ion beam voltage, ion beam current and oxygen flow on the refractive index and stress of a SiO₂ thin film were systematically studied by using the orthogonal experiment design method. The transmittance spectrum of SiO₂ thin film was measured by spectrophotometers, and its reflective ellipsometric characteristics were measured by an elliptical polarization instrument. Then, the refractive index and stress of the thin film were obtained by the multiple wavelength curve-fitting method and the elastic deformation of a thin film-substrate system, respectively. The experimental results show that the refractive indexes of SiO₂ thin film affected by preparative parameters with the weights from high to low are in a sequence of oxygen flow, substrate temperature, ion beam current and ion beam voltage and the confidence probability of effects of the first three refractive indexes is 87.03%, 71.98% and 69.53%, respectively. Moreover, the stresses of SiO₂ thin film affected by preparative parameters with the weights from high to low are in a sequence of substrate temperature, ion beam current, ion beam voltage and oxygen flow and the confidence probability of effects of the first three stresses is 95.62%, 48.49% and 37.88%, respectively. It suggests that higher oxygen flows, lower substrate temperatures and lower ion beam voltages should be selected for preparing SiO₂ thin films with low refractive indexes and lower substrate temperatures, and higher oxygen flows for preparing SiO₂ thin films with low stresses.

Keywords: SiO₂ thin film Orthogonal experiment refractivity Stress ion beam sputtering (IBS)

收稿日期 2013-04-12 修回日期 2013-05-22 网络版发布日期 2013-09-30

基金项目:

超低损耗激光薄膜基础理论与关键技术研究

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