磁控溅射法制备 ITO 膜层及其光电性能研究

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摘 要:利用直流磁控溅射法在有机玻璃基底上沉积掺杂氧化铟锡(ITO)透明导电薄膜,在室温条件下,研究了溅射功率、溅射气压、靶基距和氧氩流量比等工艺参数对 ITO 薄膜光电性能的影响。结果表明,ITO 薄膜的透光率随溅射功率和靶基距的增大而减小,当溅射功率为 110W、靶基距为 70mm 时,ITO薄膜的透光性和导电性较为优良。在近紫外光波段和近红外光波段,ITO 薄膜的透光率随溅射气压的增大而减小。当氧氩流量比为 4:30 时,ITO 薄膜在 500nm 到 600nm 可见光范围内的透光性和综合性能最好。

关 键 词:ITO 薄膜;直流磁控溅射法;溅射功率;溅射气压;光电性能

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Growth and Characterization of ITO Films Deposited by DC Magnetron Sputtering

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Abstract: The ITO films were deposited at room temperature by DC magnetron sputtering of a lab-made ITO target on organic glass substrates. The photoelectric property of the ITO film was evaluated by changing the process parameters of sputtering power, sputtering pressure, target distance and oxygen-argon flow ratio. The ITO films were characterized with ultraviolet visible near infrared spectroscopy. The results show that the transmittance of ITO films decreases with the increase of sputtering power and target-substrate distance. When the sputtering power is 110W and the target-substrate distance is 70mm, the transmittance and conductivity of ITO films are better. In the near-ultraviolet light band and the near infrared light band, the transmittance of the ITO film decreases as the sputtering pressure increases. When the oxygen-argon flow ratio is 4:30, the ITO film shows the best transmittance and comprehensive performance in the visible light range from 500nm to 600nm.

Key words: ITO thin film; DC magnetron sputtering; sputtering power; sputtering pressure; photoelectric property

近年来,人们在生产生活及能源、信息、国防等科技前沿领域中对功能薄膜材料的需求和应用越来越广泛[1-2]。其中透明导电薄膜(TCO)[3-5]是一种兼备高透光率和低电阻率的重要功能材料,具有广泛的应用价值和研究意义。在众多的透明导电氧化物薄膜中,锡掺杂氧化铟(ITO)[6-8]薄膜是一种立方锰铁矿结构的高简并 n 形半导体薄膜。薄膜的导电性能是由 Sn 元素代替 In 元素时贡献出一个电子,形成一定的载流子浓度和迁移率来实现的。同时 ITO 薄膜是一种宽禁带材料, 带隙为 3.5~4.3eV, 禁带的吸收阈值为 3.75eV,相当于 330nm 波长的能量,所以其能够实现对紫外线的高吸收, 对可见光的高透过率, 对红外线的高反射率以及对微波的高衰减率。ITO 薄膜还具有高硬度、高抗腐蚀性、加工性能良好等优点[9],被广泛应用在平面显示、抗激光损伤涂层、太阳能电池透明电极、微波电磁屏蔽、防护镜和交通工具的风挡玻璃等方面[10]。

制备 ITO 薄膜的方法有很多种,一般分为物理法和化学法。常见的物理方法有脉冲激光沉积法[11]、真空反应蒸发法[12]、磁控溅射法[13]等。常见的化学方法有溶胶-凝胶法[14]、化学气相沉积法[15]、喷雾热解法[16]等。因制备工艺和制备方法的不同,薄膜的生产效率和成膜质量不同。经大量实

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