

基于磁控溅射的纳米金属薄膜沉积工艺研究^{*}

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摘 要:半球谐振子金属化镀膜是半球谐振陀螺研制过程中的重要工艺环节,针对半球谐振子金属化镀膜后保持高 Q 值的要求,需实现纳米金属薄膜的高精度制备。本文以高纯 Al 为靶材,高纯 Ar 为溅射气体,采用 DC 磁控溅射方法在石英玻璃基片上制备纳米铝膜,并对不同溅射功率和腔室气压下沉积薄膜的厚度、表面粗糙度、表面形貌等进行了测试与表征,探讨了工艺参数对 Al 薄膜沉积速率、表面粗糙度及微观形貌的影响。研究结果表明:Al 膜的沉积速率随着溅射功率的增大而增大;随着腔室气压的增大,沉积速率呈现先增大后减小的趋势;随着溅射功率的增大,沉积薄膜的晶粒尺寸亦随之增大;随着腔室气压的增大,薄膜的颗粒直径先增大后减小;在 100W 溅射功率和 1.6Pa 腔室气压条件下镀制的薄膜最均匀致密。上述结论对于半球谐振子曲面纳米薄膜的高质量制备具有重要的指导意义。

关 键 词:磁控溅射;半球谐振子;纳米薄膜;溅射功率;腔室气压

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Nano Film Deposition Technology Based on Magnetron Sputtering

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Abstract: The metallization coating of the hemispherical resonator is an important process in the development of the hemispherical resonator gyroscope. For the requirement of maintaining a high Q value after the metallization of the hemispherical resonator, the high-precision preparation of nano metal films is required. In this paper, nano aluminum films were prepared on quartz glass substrates by DC magnetron sputtering with high purity Al as target material and high purity Ar as sputtering gas. The thickness, surface roughness and surface morphology of the films deposited under different sputtering power and chamber pressure were measured and characterized. The effects of process parameters on deposition rate, surface roughness and micro morphology of the Al films were discussed. The results show that the deposition rate of Al films increases with the increase of sputtering power. With the increase of chamber pressure, the deposition rate shows a trend of first increasing and then decreasing. With the increase of sputtering power, the grain size of the films increases, and with the increase of the chamber pressure, the particle diameter of the film increases first and then decreases. The as-coated film was the most uniform and compact under the condition of 100W sputtering power and 1.6Pa chamber pressure. The above conclusions have important guiding significance for the high-quality preparation of hemispherical harmonic oscillator curved nano films.

Key words: magnetron sputtering; hemispherical resonator; nano film; sputtering power; chamber pressure

半球谐振陀螺是一种新型高精度固体振动陀螺仪,采用高 Q 值(品质因数)的熔融石英制成,利用半球壳唇缘的径向驻波进动效应来感测基座旋转,作为航空航天、船舶、国防兵器等高端

装备中惯导系统的核心器件,对于飞行器和战略、战术武器的飞行精度和姿态稳定性起着决定性作用^[1-4]。半球谐振陀螺仪无耗损部件,对磁场不敏感,具有体积小、寿命长、精度高、可靠性高

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