

全自旋逻辑电路的仿真模型

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摘要: 为了便于对由全自旋逻辑器件构建的逻辑电路进行仿真和验证, 基于 Landau Lifshitz

Gilbert 方程建立了纳磁体磁矩动力学模型, 基于自旋注入和自旋传输机理建立了自旋传输模型, 并分别将磁矩动力学模型和自旋传输模型封装为通用的 SIMULINK 模块。根据全自旋逻辑电路的拓扑连接关系, 对这两类模块进行耦合, 构建了电路仿真模型, 实现对电路逻辑功能的仿真验证。对反相器/缓冲器和择少逻辑门电路的仿真验证了该模型的有效性。

关键词: 全自旋逻辑 (ASL); 自旋传输; Landau Lifshitz Gilbert 方程; SIMULINK 模块; 仿真模型

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Simulation Model of All Spin Logic Circuits

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Abstract: To simulate and verify the logic circuits composed by the all spin logic devices, a nano magnet magnetization dynamics model was built based on the Landau Lifshitz Gilbert equation. Based on the spin injection and spin transport mechanism, a spin transport model was built. Universal SIMULINK modules were constructed from the magnetization dynamics model and spin transport model. Based on the topological connection relations of the all spin logic circuits, two types of the modules were coupled and the simulation model of the circuit was built to realize the simulation and verification of the logic function for the all spin logic circuits. The simulations of the inverter/buffer and minority gate circuit demonstrate the validity of the model.

Key words: all spin logic (ASL); spin transport; Landau Lifshitz Gilbert equation; SIMULINK module; simulation model

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退火温度对 Ag/VO_x/Al 阻变存储器性能的影响

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摘要: 阻变存储器(RRAM)是下一代最有潜力的非易失性存储器。利用磁控溅射、电子束蒸发和离子束溅射方法制备了一种 Ag/VO_x/Al 结构的 RRAM。使用半导体参数分析仪(Agilent B1500A)测试了器件的电学特性, 器件具有双极阻变特性。器件的高阻态的传输机制为空间电荷限制电流(SCLC)机制, 低阻态的传输机制为欧姆机制, 器件的阻变机制为金属导电细丝机制。研究了不同退火温度(150~300 °C)对 Ag/VO_x/Al 器件阻变性能的影响。研究表明, 不同退火温度不仅会影响 VO_x 薄膜的表面形貌与晶面组成, 而且会影响器件的电学性能, 在退火温度为 200 °C时器件的阻变窗口最大, 而在 300 °C时器件的耐久性最优秀。适当的退火温度有益于改善器件的阻变性能。

关键词: VO_x 薄膜; 阻变存储器(RRAM); 金属导电细丝机制; 磁控溅射; 退火温度

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Effects of the Annealing Temperature on the Performances of the Ag/VO_x/Al Resistive Random Access Memory

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Abstract: Resistive random access memory(RRAM) is the next generation of the most promising nonvolatile memory. A RRAM with Ag/VO_x/Al structure was prepared by magnetron sputtering, electron beam evaporation and ion beam sputtering methods. The electrical characteristics of the device were measured by semiconductor parameter analyzer (Agilent B1500A). The device shows bipolar resistance swithing characteristics. The transmission mechanisms of the high resistive state and the low resistive state for the device are the space charge limited current (SCLC) mechanism and ohmic mechanism, respectively, and the resistance swithing mechanism of the device is the metal conductive filament mechanism. The effects of different annealing temperatures (150-300 °C) on the resistance swithing performance of Ag/VO_x/Al devices were studied. The research shows that different annealing temperatures can affect the surface morphology and crystal plane composition of the VO_x thin film, and the electrical properties of the devices. The device shows the widest resistance swithing window at the annealing temperature of 200 °C and the best durability performance at the annealing temperature of 300 °C. The proper annealing temperature is beneficial to improve the resistance swithing performance of the device.

Key words: VO_x thin film; resistive random access memory(RRAM); metal conductive filament mechanism; magnetron sputtering; annealing temperature

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摘要: 为进一步提升红外气体传感器的性能, 提出了一种可实现辐射自增强的多层纳米交叠复合非晶碳薄膜材料应用于红外光源, 对材料制备的关键工艺及性能表征进行了深入研究, 以期大幅提高光源的辐射效率, 降低功耗。采用非平衡磁控溅射工艺制备了含钛的周期性非晶碳复合薄膜, 在不同退火条件下进行了方阻及光学吸收率测试表征。结果表明, 多层纳米厚度交叠薄膜有效降低了薄膜的应力; 氧等离子体表面刻蚀调控工艺实现了高辐射率纳米纤维材料的集成制备; 制备的非晶碳纳米复合薄膜在高温 800 °C 退火后呈现出良好的电阻热稳定性, 在波长 5~6 μm 内吸收率大于 80%, 最高接近 84%。本工作为该辐射自增强的非晶碳薄膜应用于 MEMS 红外光源提供了一定的技术支持。

关键词: 非晶碳; 红外光源; 辐射自增强; 辐射性能; 吸收率

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Performance of the Amorphous Carbon Thin Films with Radiation

Self Enhancement for IR Source

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Abstract: In order to further improve the performance of the infrared gas sensors, the multi layer overlapping nanocomposite amorphous carbon thin films with radiation self enhancement for IR source were presented. The key preparation process and performance characterization of the material were studied to significantly improve the radiation efficiency of sources and reduce power consumption. The periodic amorphous carbon composite thin films containing titanium were prepared by the unbalanced magnetron sputtering process, and the square resistances and optical absorptivity were measured and characterized under different annealing conditions. The results show that the multi layer overlapping nano films can effectively reduce the stress of the thin films, and the oxygen plasma surface etching regulation process can realize the integrated preparation of nanofiber materials with high radiance. The prepared amorphous carbon nanocomposite thin films exhibit a good resistance thermal stability after annealing at 800 °C, and the absorptivity is more than 80% and the maximum absorptivity is close to 84% in the wavelength range of 5-6 μm. This work provides a certain technical support for the application of radiation self enhancement amorphous carbon thin films to MEMS IR sources.

Key words: amorphous carbon; infrared source; radiation self enhancement; radiation property; absorptivity

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基于分支结构碳纳米管纳米销的安装性能

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摘要: 采用经典分子动力学 (MD) 方法对几种基于分支结构碳纳米管 (CNT) 的纳米销进行安装过程模拟, 比较了两种安装方式, 重点研究了双支管纳米销的安装可行性及控制端长度对双支管纳米销安装性能的影响。研究表明: 相比于推安装, 拉安装不仅将其支管的安装提前了, 也将安装过程中的最大安装阻力提升了一个量级, 因此推安装更加实用; 双支管纳米销可以被成功安装, 但具有更多支管的纳米销由于支管关节引起的主管轻微弯曲需要更严格的筛选和定位误差修正; 20 nm 的控制端长度和第二支管位置并不会直接造成双支管纳米销主管的屈曲。因此, 双分支结构碳纳米管可以实现纳米器件的安装准确性和纳米构件的有效连接, 而具有更多支管的纳米销的安装则需要进一步探索和优化。

关键词: 纳米器件; 分子动力学 (MD); 纳米销; 碳纳米管 (CNT); 连接; 集成

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Installation Performances of the Nanopins Based on the
Branched Carbon Nanotubes

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Abstract: The simulations on the installation processes of the nanopins based on the several kinds of branched carbon nanotubes (CNTs) were conducted by the classic molecular dynamics (MD) method. Two installation methods were compared. The installation feasibility of the nanopins with double branches and the effects of the lengths of the control ends on the installation performance of the nanopins with double branches were mainly researched. The results show that compared with the push installation, the pull installation can advance the installation process of the branch and the maximum installation resistance during the installation process increases an order of magnitude, and thus the push installation is more practical. The nanopins with double branches can be installed successfully, but the nanopins with more branches need the stricter selection and positioning error correction due to the slight bend of the trunk tube caused by the branch joint. The control end length of 20 nm and the position of the second branch cannot directly lead to the buckling of the trunk tube for the nanopins with double branches. Therefore, the CNTs with double branches can realize the accurate installation of the nanodevices and the effective connection of the nano components, but the installation of the nanopins with more branches needs further investigation and optimization.

Key words: nanodevice; molecular dynamics (MD); nanopin; carbon nanotube (CNT); connection; integration

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Eu³⁺掺杂的 MoS₂ 薄膜的光电特性

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摘要: 为了研究 Eu³⁺掺杂 MoS₂ 薄膜的光电特性, 采用气相运输沉积法在 p-Si 衬底上沉积 MoS₂ 薄膜, 并利用原子力显微镜(AFM)、X 射线衍射仪(XRD)、霍尔效应仪、分光光度计和光致发光光谱仪研究了 Eu³⁺掺杂对 MoS₂ 薄膜的表面形貌、晶体结构、光吸收以及 MoS₂-Si 异质结的光电流的影响。研究表明: Eu³⁺掺杂使 MoS₂ 薄膜的结晶更好; 同时 MoS₂ 薄膜的电子迁移率和电导率增加了一个数量级, 并使 MoS₂-Si 异质结具有良好的伏安特性和光电响应。另外, Eu³⁺掺杂增强了 MoS₂ 薄膜的光吸收, 并使 MoS₂ 薄膜在室温下产生红光。以上结果表明, Eu³⁺掺杂 MoS₂ 薄膜可用于制作高效率的发光与光电子器件。

关键词: MoS₂; Eu³⁺; 光电流; 光吸收; 光致发光

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Photoelectric Characteristics of Eu³⁺-Doped MoS₂ Thin Films

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Abstract: To study the photoelectric characteristics of Eu³⁺-doped MoS₂ thin films, the MoS₂ thin films were deposited on the p-Si substrates by the vapor transport deposition method. And the effects of the Eu³⁺ doping on the surface morphology, crystal structure, light absorption of MoS₂ thin films and the photocurrent of the MoS₂-Si heterojunction were studied by the atomic force microscope(AFM), X-ray diffractometer(XRD), Hall effect device, spectrophotometer and photoluminescence spectrometer. The research shows that the crystallinity of the Eu³⁺-doped MoS₂ thin film is better. Meanwhile, the electron mobility and conductivity of the MoS₂ thin films increase an order of magnitude, and the MoS₂-Si heterojunction has good voltage-current characteristic and photoelectric response. Moreover, the Eu³⁺-doped MoS₂ thin films exhibit strong light absorption and produce red light at room temperature. The results show that the Eu³⁺-doped MoS₂ thin films can be used to fabricate high efficient luminescence and optoelectronic devices.

Key words: MoS₂; Eu³⁺; photocurrent; light absorption; photoluminescence

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硅微机械陀螺仪温度补偿方法的研究现状

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摘要: 综述了硅微机械陀螺仪温度补偿方法的研究现状。介绍了陀螺仪的基本原理, 并分析了陀螺仪的温度特性。分别对温度控制、器件设计和算法补偿三种温度补偿方法进行了原理和结果分析, 总结了各种方法的优势与不足。介绍了算法补偿中两种常用的温度误差模型构建方法, 算法补偿既符合小体积、低成本的设计理念, 又能有效提升陀螺仪的温度稳定性, 但复杂的算法需要强大的内存支撑, 系统的响应速度亦会受到影响, 因此在算法的优化设计方面仍有巨大的研究潜力和空间。随着陀螺仪数字化进程的不断推进, 温度误差模型构建的标准化方法以及优化的算法是未来进一步的发展方向。

关键词: 微机械系统 (MEMS); 陀螺仪; 零偏稳定性; 温度补偿; 软件算法补偿

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Research Status of Temperature Compensation Methods for

Silicon Micro Electromechanical Gyroscopes

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Abstract: The research status of temperature compensation methods of silicon micro electromechanical gyroscopes is reviewed. The basic principle of the gyroscope is introduced and the temperature characteristics of the gyroscope are analyzed. The principle and result analyses of three kinds of temperature compensation methods, namely temperature control, device design and arithmetic compensation are carried out, respectively. The advantages and disadvantages of the methods are summarized. Two kinds of the common temperature error model establishment methods in the arithmetic compensation are introduced. The arithmetic compensation has the design concept of small volume and low cost and can effectively improve the temperature stability of gyroscopes, but the complex algorithm needs the large memory as the support and affects the response speed of the system. So there is a great research potential and space in the optimal design of the arithmetic. With the unceasing advancement of the digitization process of gyroscopes, the standardized methods of the temperature error model establishment and the optimized arithmetic are the further development directions in the future.

Key words: micro electromechanical system (MEMS); gyroscope; bias stability; temperature compensation; software arithmetic compensation

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基于 MEMS 的虚拟现实步迹跟踪系统的设计

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摘要: 针对大多数虚拟现实体验中的人物运动主要靠手柄按键操作的问题, 设计了一种基于佩戴者自身步态运动的虚拟现实系统, 采用低成本、普通精度的 MEMS 惯性传感器采集佩戴者的足部姿态信息, 从而实现无需外部设备的行人步迹的跟踪定位。根据惯性原理进行姿态解算, 并对传感器采集数据进行分析研究, 设计了多条件零速判定方法和主航向收敛算法, 实现速度和方向的修正补偿, 并使用样机进行真实实验。实验结果表明, 该系统能够实现行人的步态分析, 修正后的跟踪定位轨迹误差不大于 0.316 m, 可根据应用需求进行扩展研究。

关键词: 虚拟现实; 微电子机械系统 (MEMS); 姿态; 步迹跟踪; 零速修正

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Design of a Virtual Reality Footstep Tracking System

Based on MEMS

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Abstract:For the most body motions in the virtual reality experience depending mainly on pressing the handle buttons, a virtual reality system based on the wearer own gait was designed. The pedestrian footstep tracking without external equipments was realized by using the MEMS inertia sensors with low cost and general precision to acquire the foot posture information of the wearer. According to the inertia principle to conduct the attitude resolve, and the collected data of the sensors were analyzed and researched. The multi condition zero velocity determination method and main direction convergence algorithm were designed to realize the compensation of speed and direction, and the experiment was carried out by using the prototype. The experimental results show that the system can realize the gait analysis of the pedestrian, and the corrected tracking positioning error is no more than 0.316 m, which can extend the research according to the application requirements.

Key words:virtual reality; micro electromechanical system (MEMS); attitude; footstep tracking; zero velocity updating

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硅腔体 MEMS 环行器的设计与制作

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摘要: 设计制作了一种基于 MEMS 工艺的硅腔体环行器。该环行器以高阻硅为衬底材料, 基于基片集成波导 (SIW) 技术的传输理论, 采用体硅 MEMS 工艺和低损耗金属化技术实现了硅通孔及通孔金属化的制备。设计并仿真优化了硅腔体 MEMS 环行器结构, 给出了一套硅腔体 MEMS 环行器制备的工艺流程, 针对该工艺流程方案进行了关键参数的工艺误差仿真。实现了中心频率为 13 GHz MEMS 环行器的工艺制作和性能测试, 频带内插损小于 0.5 dB, 电压驻波比 (VSWR) 小于 1.25, 隔离度大于 20 dB, 环行器尺寸仅为 11.0 mm×11.0 mm×2.5 mm, 远小于对应的波导腔体环行器。

关键词: 微电子机械系统(MEMS); 基片集成波导 (SIW); 硅通孔 (TSV) 技术; 环行器; 硅腔体; 低损耗

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Design and Fabrication of a MEMS Silicon Cavity Circulator

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Abstract:A silicon cavity circulator was designed and fabricated based on MEMS process. With the high resistance silicon as the substrate material and based on the transmission theory of the substrate integrate waveguide (SIW) technology, the through silicon via (TSV) and metallization were fabricated by the bulk silicon MEMS process and low loss metallization technology. The structure of the MEMS silicon cavity circulator was designed, simulated and optimized. A fabrication process of the MEMS silicon cavity circulator was presented. Based on the process scheme, the error simulation of the key parameters was carried out. The fabrication and performance test of the MEMS circulator with the center frequency of 13 GHz were realized. The in band insertion loss is less than 0.5 dB, the voltage standing wave ratio (VSWR) is less than 1.25, and the isolation is more than 20 dB. The size of the circulator is only 11.0 mm×11.0 mm×2.5 mm and is much smaller than that of the corresponding waveguide cavity circulators.

Key words:micro electromechanical systems (MEMS); substrate integrated waveguide (SIW); through silicon via (TSV) technology; circulator; silicon cavity; low loss

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单电子晶体管与原子力扫描探针的集成

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摘要: 单电子晶体管 (SET) 可用作超灵敏电荷计, 将 SET 集成到原子力扫描探针上, 可得到对被测样品的表面形貌和电荷空间分布扫描成像。介绍了一种硅基台阶型原子力扫描探针与 SET 的集成方案。一对共漏极的 SET 集成在台阶型针尖上, 台阶型的针尖和静电探针的设计避免了 SET 的刻蚀损伤。通过 SET 和静电探针的电容耦合来实现电荷探测。将扫描探针与石英音叉进行组装, 在 8 K 低温下成功实现了间距 2 μm 金属光栅 10° 倾角的形貌扫描, 并获得形貌图, 针尖上的 SET 具有良好的库仑阻塞效应和单电子隧穿特性。

关键词: 单电子晶体管 (SET); 原子力扫描探针; 绝缘体上硅 (SOI); 台阶型针尖; 石英音叉

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Integration of the Single Electron Transistor with the Atomic Force Scanning Probe

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Abstract: The single electron transistor (SET) can be used as a ultra sensitive charge detector. By the integration of the SET with the atomic force scanning probe, the scanning images of the surface morphology and charge spatial distribution for the measured sample were obtained. An integration scheme of the silicon based step typed atomic force scanning probe and SET was introduced. A pair of common drain SETs were integrated on the step typed probe tip. The designs of the step shaped probe tip and electrostatic probe can prevent the damage of SET during the etching process. The charge detection was realized by capacitive coupling of the SET and electrostatic probe. The scanning probe and quartz tuning fork were assembled to successfully achieve the morphological scanning image of the metal gratings with 2 μm gap at 10° inclination under 8 K low temperature. The SET on the probe has a good coulomb blockade effect and single electron tunneling characteristics.

Key words: single electron transistor (SET); atomic force scanning probe; silicon on insulator (SOI); step shaped needle tip; quartz tuning fork

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ZnO 纳米棒的制备及其荧光检测性能

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摘要: 在微流控芯片中采用水热法合成 ZnO 纳米棒。使用扫描电子显微镜 (SEM) 和 X 射线衍射 (XRD) 分别对 ZnO 纳米棒的微观形貌和晶体结构进行分析和表征。结果表明, 在微流控芯片中制备的致密的 ZnO 纳米棒具有良好的结晶性和 c 轴取向性, ZnO 纳米棒的直径和长度随制备时间和在通道中的不同位置发生变化。利用异硫氰酸荧光素 (FITC) 标记的羊抗牛 IgG 对 ZnO 纳米棒的荧光检测性能进行测试, 实验结果表明, 制备时间为 3 h 的 ZnO 纳米棒具有最优的荧光检测性能。在对人甲胎蛋白 (AFP) 进行检测时, 其质量浓度检测限可达 10^{-3} ng/mL, 且具有较宽的检测范围 (质量浓度为 $10^{-3}\sim 10$ ng/mL⁻¹)。

关键词: 氧化锌(ZnO); 微流控芯片; 荧光检测; 生物传感器; 癌症标志物

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Preparation and Fluorescence Detection Property of ZnO Nanorods

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Abstract: ZnO nanorods were synthesized in the microfluidic chip by the hydrothermal method. The micromorphologies and crystal structures of ZnO nanorods were analyzed and characterized by the scanning electron microscope (SEM) and X ray diffraction (XRD), respectively. The experimental results show that the densely packed ZnO nanorods prepared in the microfluidic chip have good crystallinity and c axis orientation. The diameters and lengths of the ZnO nanorods change with the preparation time and different spots in the channels. The fluorescence detection properties of the ZnO nanorods were tested by the FITC labeled goat anti bovine IgG. The result shows that the fluorescence detection property of the ZnO nanorods prepared for 3 h is optimal. When the human alpha fetoprotein (AFP) is detected, the detection limit of the mass concentration can reach 10^{-3} ng/mL, and it has a wide detection range (the mass concentration of 10^{-3} - 10 ng/mL).

Key words: ZnO; microfluidic chip; fluorescence detection; biosensor; cancer biomarker

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AZ4620 光刻胶掩膜的氮化硅图形化工艺

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摘要: 以薄膜体声波谐振器 (FBAR) 的背腔刻蚀为研究背景, 研究了光刻工艺参数设置与光刻图形转移效果的关系。分析了紫外曝光剂量大小对光刻图形面积和边角曲率的影响, 优化得到最佳工艺流程, 以 AZ4620 光刻胶为掩膜实现了氮化硅的湿法刻蚀。实验结果表明, 曝光剂量为 60 mJ、显影时间 60 s 时, 曝光图形化质量最佳; 随着氮化硅刻蚀液温度的升高, 湿法刻蚀速率不断增大, 温度过高导致光刻胶被破坏而不能起到掩膜作用, 60 °C 时刻蚀速率为 109 5 nm/min, 得到了边线规整、底部平整的微结构。刻蚀后表面分子喇曼位移为单晶硅的波峰 (519 354 cm⁻¹), 证实氮化硅被完全去除, 为氮化硅作掩膜的单晶硅湿法刻蚀提供了一种有效途径。

关键词: 曝光剂量; 掩膜; 湿法刻蚀; 刻蚀速率; 喇曼位移

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Silicon Nitride Graphical Processing of AZ4620 Photoresist Mask

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Abstract: With the back cavity etching of a film bulk acoustic resonator (FBAR) as the research background, the relationship between the parameter setting of lithographic process and the transfer effect of lithography pattern was studied. The effects of the UV exposure dose on the area and corner curvature of the lithography pattern were analyzed. The optimal technological process was obtained. The wet etching of silicon nitride was realized by using AZ4620 photoresist as the mask. The experiment shows that the quality of the exposure pattern is the best with the condition of the exposure dose of 60 mJ and the developing time of 60 s. With the increase of the temperature of the silicon nitride etching liquid, the wet etching rate increases continuously. When the temperature is too high, the photoresist is destroyed and can't play the role of the mask. The microstructure with good quality in both the edge and bottom is obtained when the etch rate is 109 5 nm/min at 60 °C. The Raman shift of the surface molecule is the wave peak of monocrystalline silicon (519 354 cm⁻¹) after etching, which confirms that the silicon nitride is completely removed and provides an effective way for monocrystalline silicon wet etching with silicon nitride as the mask.

Key words: exposure dose; mask; wet etching; etching rate; Raman shift

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基于地磁滚转角测量系统陀螺在线标定技术

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摘要: 针对弹载陀螺在发射过程中产生较大过载导致陀螺零点和灵敏度发生变化的问题, 提出了一种利用地磁测量信息对陀螺进行在线标定的方法。该方法是利用最小二乘法对地磁场提供的滚转角信息与陀螺的数据进行拟合得到陀螺的标定参数: 零点误差和灵敏度误差。通过仿真实验表明, 采样点数为 10 时标定的效果最好。接着研究了速率对陀螺标定精度的影响。在外场实验中在线标定方法角速率误差为 $7.86^\circ/\text{s}$, 相比速率标定方法, 该角速率误差减小到原来的 $1/10$ 。仿真实验和外场实验都表明在线标定方法所得到的角速率精度有明显提高。

关键词: 陀螺; 在线标定; 最小二乘法; 地磁信息; 速率标定法

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On Line Calibration Technique of the Gyroscope Based on the Geomagnetic Roll Angle Measurement System

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Abstract: For the problem that ballistic axial gyroscope can produce a larger overload resulting in the changes of its zero point and sensitivity during the launching process, an on line calibration method of the gyroscope was proposed by using the geomagnetic measurement information. To obtain the calibration parameters of the gyroscope, i.e., the zero point error and sensitivity error, the least squares method was used to fit the gyroscope data and roll angle information provided by the geomagnetic field. The simulation experiment shows that the calibration effect is the best when the sampling number is 10. Then the effect of the rate on the calibration accuracy of the gyroscope was studied. In the out field experiment, the angular rate error of the on line calibration method is $7.86^\circ/\text{s}$, which reduces to $1/10$ compared with that of the rate calibration method. Both the simulation and out field experiments show that the accuracy of the angular rate is improved significantly by using the on line calibration method.

Key words: gyroscope; on line calibration; least square method; geomagnetic information; rate calibration method

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