

β Ⅱ Ga₂O₃ 欧姆接触的研究进展

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摘要: 近年来, 随着氧化镓 (Ga₂O₃) 晶体生长技术取得突破性进展, 氧化镓材料及器件的研究与应用成为国际上超宽禁带半导体领域的研究热点。综述了 β Ⅱ Ga₂O₃ 衬底的一些优点以及面临的挑战, 重点介绍了如何实现良好的欧姆接触。围绕采用低功函数金属、表面预处理、衬底掺杂和引入中间层的方法, 阐述了目前国际上金属/ β Ⅱ Ga₂O₃ 欧姆接触的最新研究进展。总结了不同实验条件下可以获得的比接触电阻, 目前可以获得的最低比接触电阻是 $4 \sim 6 \times 10^{-6} \Omega \cdot \text{cm}^2$ 。最后, 预测未来金属/ β Ⅱ Ga₂O₃ 欧姆接触的主要研究方向是提高欧姆接触的热稳定性。

关键词: β Ⅱ Ga₂O₃; 欧姆接触; 功率器件; 金属-氧化物-半导体场效应晶体管 (MOSFET); 金属电极

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Research Progress on Ohmic Contact for β Ⅱ Ga₂O₃

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Abstract: In recent years, with the breakthrough of gallium oxide (Ga₂O₃) crystal growth technology, the research and application of Ga₂O₃ materials and devices become an international research hotspot in the field of ultra Ⅱ wide band gap semiconductors. The advantages and challenges of the β Ⅱ Ga₂O₃ substrate are overviewed, and how to achieve good Ohmic contact is introduced emphatically. The latest international research progresses of metal/ β Ⅱ Ga₂O₃ Ohmic contact are illustrated, including the adoption of low work function metal, surface pretreatment, substrate doping and introducing interfacial layers. The specific contact resistance obtained under different experimental conditions is summarized, the currently obtained lowest specific contact resistance is $4 \sim 6 \times 10^{-6} \Omega \cdot \text{cm}^2$. Finally, it is predicted that the main direction for future metal/ β Ⅱ Ga₂O₃ Ohmic contact is to improve the thermal stability of Ohmic contact.

Key words: β Ⅱ Ga₂O₃; Ohmic contact; power device; metal Ⅱ oxide Ⅱ semiconductor field effect transistor (MOSFET); metal electrode

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柔性可延展电路中互连结构设计及布局优化

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摘要: 针对柔性可延展电路由于不合理的互连结构设计和布局而造成的串扰问题, 提出一种基于响应面法对柔性可延展电路互连结构进行设计与布局的方法。以柔性可延展电路中的通用互连结构为研究对象, 通过正交实验和方差分析, 筛选出对串扰存在显著性影响的因素。基于正交设计分析结果, 运用中心复合实验设计法获得样本数据, 利用 ANSYS Electronic Desktop 获得串扰响应值, 构建串扰与影响因子之间的二阶多项式响应面模型, 以近端串扰和远端串扰之和的最小值为优化目标建立优化模型, 通过优化算例验证了该方法的可行性, 为可延展通用互连导线的优化与布局提供了参考依据。

关键词: 互连结构; 可延展电路; 串扰; 正交实验; 方差分析

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Structure Design and Layout Optimization of Interconnection
in Flexible and Stretchable Circuits

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Abstract: Aiming at the crosstalk problem caused by unreasonable interconnection structure design and layout of flexible and stretchable circuits, a method based on response surface method for the interconnection structure design and layout of flexible and stretchable circuits was proposed. With the general interconnection structure of flexible and stretchable circuits as the research object, the factors with significant influence on crosstalk were screened out by the orthogonal test and variance analysis. Based on the analysis results of the orthogonal design, the central composite experiment design method was used to obtain sample data. The crosstalk response values were obtained by the ANSYS Electronic Desktop to build the second order polynomial response surface model between crosstalk and impact factors. The optimization model was established with the minimum value of the sum of near crosstalk and far crosstalk as the optimization objective, and the feasibility of the method was verified by an optimization example. The method provides a reference for the optimization and layout of the stretchable general interconnection conductors.

Key words: interconnection structure; stretchable circuit; crosstalk; orthogonal test; variance analysis

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1,3 二巯基丙烷对聚合物/非富勒烯 太阳能电池的影响

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摘要: 选用 1,3 二巯基丙烷 (DMP) 作为添加剂加入到聚合物材料 PBDB 卩 T 与非富勒烯材料 ITIC 的共混体系中, 制备以 PBDB 卩 T : ITIC 作为活性层材料的体异质结聚合物太阳能电池。实验发现, DMP 可以有效地改善活性层的形貌, 促进激子的产生与解离。DMP 对聚合物的结晶形貌改善的作用较小, 但对非富勒烯材料 ITIC 的结晶结构有序性的影响显著。将 DMP 加入活性层中, 可使非富勒烯材料 ITIC 晶畴的相干长度显著增加, 这意味着 ITIC 结晶结构有序性的提高, 这有利于电子的传输。加入质量分数 1% 的 DMP 后, 器件的光电转换效率由未添加 DMP 时的 7 卩 80% 提高至 8 卩 98%, 证明 DMP 的应用是一种提高聚合物/非富勒烯太阳能电池性能的简单高效的方法。

关键词: 聚合物/非富勒烯太阳能电池; 溶剂添加剂; 形貌; 结构有序性; 光电转换效率

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Effect of 1,3 卩 Dimercaptopropane on Polymer/
Non 卩 Fullerene Solar Cells

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Abstract: As an additive, 1,3 卩 dimercaptopropane (DMP) was added to the polymer material PBDB 卩 T and non 卩 fullerene material ITIC blend system, and the bulk 卩 heterojunction polymer solar cell with the PBDB 卩 T : ITIC as the active layer material was prepared. The experiment result shows that the DMP can effectively improve the morphology of the active layer and promote the generation and dissociation of excitons. The effect of the DMP on crystal morphology improvement of polymer is small, but the effect of the DMP on the structure order of non 卩 fullerene material ITIC crystalline is more distinct. The addition of the DMP to the active layer can significantly increase the coherence length of the ITIC crystal domain, which means the improvement of structure order in the ITIC crystalline, being conducive to electron transport. The photoelectric conversion efficiency of the device increases from 7 卩 80% without DMP to 8 卩 98% after addition of the DMP with the mass fraction of 1%. It is proved that the use of DMP is a simple and efficient way to improve the performances of polymer/non 卩 fullerene solar cells.

Key words: polymer/non 卩 fullerene solar cell; solvent additive; morphology; structural order; photoelectric conversion efficiency

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具有高击穿电压的 AlN 背势垒 AlGaN/
GaN/AlN HEMT 材料

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摘要: 采用金属有机化学气相沉积 (MOCVD) 技术在 4 英寸 (1 英寸=2.54 cm) 蓝宝石衬底上制备了 1.2 μm 厚的 AlN 背势垒的 AlGaN/GaN/AlN 双异质结高电子迁移率晶体管 (HEMT) 材料, 其 AlGaN 势垒层表面粗糙度 (RMS)、二维电子气 (2DEG) 迁移率以及 HEMT 材料的弯曲度都较为接近于常规的高阻 GaN 背势垒结构的 HEMT 材料。由于 AlN 晶格常数较小, 具有 AlN 背势垒的 HEMT 材料受到了更大的压应力。通过对比分析两种 HEMT 材料所制备的器件发现, 受益于 AlN 背势垒层更高的禁带宽度和临界电场, 由 AlN 背势垒 HEMT 材料所制备的器件三端关态击穿电压为常规高阻 GaN 背势垒 HEMT 器件的 1.5 倍, 缓冲层漏电流则较常规高阻 GaN 背势垒 HEMT 器件低 2~3 个数量级。

关键词: 氮化镓 (GaN); 铝镓氮 (AlGaN); 金属有机化学气相沉积 (MOCVD); 背势垒; 高电子迁移率晶体管 (HEMT)

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High Breakdown Voltage AlGaN/GaN/AlN HEMT

Material with AlN Back Barrier

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Abstract:The AlGaN/GaN/AlN double heterojunction high electron mobility transistor(HEMT) material with 1.2 μm thickness AlN back barrier was fabricated on the 4 inch (1 inch=2.54 cm) sapphire substrate by metal organic chemical vapor deposition (MOCVD) technology. The AlGaN barrier layer surface roughness (RMS), two dimensional electron gas (2DEG) mobility and HEMT material tortuosity of the fabricated HEMT material were close to those of the conventional HEMT material with high resistivity GaN back barrier. Due to the small lattice constant of AlN, the compressive stress of HEMT material with the AlN back barrier is larger. Two kinds of the devices fabricated by the two kinds of HEMT materials were compared and analyzed. The results show that benefiting from the higher band gap and critical electric field of the AlN back barrier, the three terminal off state breakdown voltage of the HEMT device with the AlN back barrier is 1.5 times of that of the conventional HEMT device with high resistance GaN back barrier, while the leakage current of the buffer layer is 2-3 orders of magnitude lower than that of the conventional high resistance GaN back barrier HEMT device.

Key words:GaN; AlGaN; metal organic chemical vapor deposition (MOCVD); back barrier; high electron mobility transistor(HEMT)

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染料敏化太阳能电池染料协同敏化及其吸附机理

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摘要: 提取了菠菜、藏红花、金银花、雪菊、山楂 5 种光谱吸收区间不同的植物染料, 根据光谱吸收互补性的原则以不同类型、不同比例进行了混合, 用于染料敏化太阳能电池(DSSC)光阳极的协同敏化, 测定了各种染料、染料与 TiO₂ 吸附后的 UV-Vis 吸收光谱及不同染料敏化后的 DSSC 光电性能。实验结果表明: 光谱吸收区间不同的染料混合后能有效拓宽光谱吸收范围和峰值吸光度, 5 种染料以相应比例协同敏化后的电池性能最佳, 与单一染料敏化性能中最好的菠菜敏化电池相比, 开路电压提升 0.023 V, 短路电流提升 0.342 mA·cm⁻², 光电转换效率提升 0.94%(相比提升 2.68 倍)。最后从染料的有效色素类型与 TiO₂ 薄膜之间的吸附机理入手解释了造成几种染料电池光电性能差异的原因, 从而提出了混合染料协同敏化 DSSC 应遵循的几项基本原则。

关键词: 染料敏化太阳能电池(DSSC); 协同敏化; 光电性能; 吸附性; TiO₂

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Dyes Co-sensitized and Adsorption Mechanism of Dye Sensitized Solar Cells

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Abstract: Five kinds of plant dyes with different spectral absorption intervals were extracted from spinach, saffron, honeysuckle, snow chrysanthemum and hawthorn. They were mixed according to the principle of spectral absorption complementary in different types and different proportions for co-sensitization of the dye sensitized solar cell(DSSC) photo-anode. The UV-Vis absorption spectra of various dyes, dyes and TiO₂ post-absorption, and the photoelectric properties of DSSCs after dye sensitization were measured. The experimental results show that the spectral absorption range and peak absorbance can be broadened after mixing the dyes with different spectral absorption intervals. The performance of the cell is optimal after synergistic sensitization with the five kinds of dyes in the corresponding proportions. Compared with the best spinach sensitized cell in single dye sensitization performances, the open-circuit voltage increases by 0.023 V, the short-circuit current increases by 0.342 mA·cm⁻², the photoelectric conversion efficiency increases by 0.94%(2.68 times increase in contrast). Finally, from the adsorption mechanism between the effective pigment type of dyes and TiO₂ film, the reasons for the difference in photoelectric properties of several dye cells were explained, and several basic principles for mixed dye co-sensitized DSSCs were proposed.

Key words: dye sensitized solar cell(DSSC); co-sensitization; photoelectric property; adsorption; TiO₂

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基于热模压和切削减薄工艺制备
聚合物微静电驱动器

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摘要: 为了满足运输蛋白质、细胞等微纳米级物体的需求, 有必要研制聚合物微静电梳齿驱动系统。与硅静电梳齿驱动器相比, 聚甲基丙烯酸甲酯 (PMMA) 静电梳齿驱动器具有成本低、成品率高、驱动电压低和能耗少等优点。首先通过微细加工工艺, 制备硅静电梳齿驱动器模具。基于硅模具, 利用热模压工艺制备 PMMA 微驱动器, 再通过机械切削工艺释放制备好的 PMMA 微驱动器结构, 得到带基底的 PMMA 微静电梳齿驱动器, 最后通过切削减薄工艺, 释放静电梳齿微结构, 得到可动的 PMMA 微静电梳齿驱动器。驱动结果表明, PMMA 微静电梳齿驱动器制备工艺具有可行性。

关键词: 微驱动器; 聚甲基丙烯酸甲酯 (PMMA); 硅模具; 热模压工艺; 切削减薄工艺

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Preparation of Polymer Micro μ Electrostatic Actuator Based on
Hot μ Embossing and Cutting Processes

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Abstract: In order to meet the needs of transporting proteins, cells and other micro μ nanoscale objects, it is necessary to develop a polymer micro μ electrostatic comb μ drive system. Compared with the silicon electrostatic comb μ drive actuator, the polymethyl methacrylate (PMMA) electrostatic comb μ drive actuator has the advantages of low cost, high yield, lower driving voltage and lower energy consumption. Firstly, a silicon electrostatic comb μ finger actuator mold was prepared by the micromachining process. Based on the silicon mold, the PMMA micro μ actuator was prepared by the hot μ embossing process, and the prepared PMMA micro μ actuator structure was released by the mechanical cutting process to obtain the PMMA micro μ electrostatic comb μ drive actuator with the substrate. Finally, the electrostatic comb microstructure was released by using the cutting process to obtain a movable PMMA micro μ electrostatic comb μ drive actuator. The driving results show that the preparation process of the PMMA micro μ electrostatic comb μ drive actuator is feasible.

Key words: micro μ actuator; polymethyl methacrylate (PMMA); silicon mold; hot μ embossing process; cutting process

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石墨烯压力传感器的设计与制作

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摘要: 为了降低电容式石墨烯压力传感器的成本, 对石墨烯压力传感器的结构与工艺进行研究, 简化加工工艺步骤, 设计并制作出石墨烯传感器样片, 该传感器样片的灵敏度分为多个区间, 最高可达 608 MPa⁻¹。首先, 将石墨烯溶液制作成纸, 利用雕刻工艺将石墨烯纸雕刻成为不同规格的平行叉指图形, 并用聚二甲基硅氧烷 (PDMS) 薄膜覆盖制作成为石墨烯压力传感器。然后, 对样片进行静态与动态性能的测试, 对测试结果进行对比分析。结果表明该传感器制作工艺简单、成本低廉、性能优良。最后论证了传感器的可行性。

关键词: 石墨烯; 叉指图形; 电容式传感器; 聚二甲基硅氧烷 (PDMS) 薄膜; 压力传感器

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Design and Fabrication of a Graphene Pressure Sensor

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Abstract: In order to reduce the cost of capacitive graphene pressure sensors, the structure and process of the graphene pressure sensor were studied, and the processing steps were simplified. The graphene sensor sample was designed and fabricated. The sensitivity of the sensor sample can be divided into several intervals, up to 608 MPa⁻¹. Firstly, the graphene solution was made into paper, the graphene paper was carved into parallel interdigital figures with different specifications by the carving process, and the graphene pressure sensor was fabricated by covering with polydimethylsiloxane (PDMS) film. Then, the static and dynamic performances of the sample were tested, and the test results were compared and analyzed. The results show that the fabricated sensor has the advantages of simple fabrication process, low cost and excellent performances. Finally, the feasibility of the sensor was proved.

Key words: graphene; interdigital figure; capacitive sensor; polydimethylsiloxane (PDMS) film; pressure sensor

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基于改进等效电容模型的数字微流控
液滴定位反馈系统

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摘要: 基于介电润湿(EWOD)效应的数字微流控技术是近十年来出现的一种能够在平面上操控体积为微升、纳升级别液滴的新技术。为了满足对数字微流控中液滴精准驱动与控制的迫切需求, 结合现有的液滴定位方法的研究, 设计了改进的等效电容模型, 该模型方法在无输入参数下实现多液滴的定位。基于该液滴定位模型, 提出了驱动参数的反馈优先级调整策略, 最终实现了一套具备驱动、定位及反馈一体的数字微流控控制系统。实验结果表明提出的方案有利于提高微液滴的连续运输的成功率, 在同样的芯片参数结构下, 成功率提高了接近40%, 对数字微流控系统进一步的应用研究具有一定指导意义。

关键词: 介电润湿(EWOD); 数字微流控; 等效电容模型; 反馈优先级; 精准驱动与控制

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Digital Microfluidic Droplet Positioning and Feedback System

Based on Improved Equivalent Capacitance Model

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Abstract: Digital microfluidic technology based on electrowetting on dielectric(EWOD) effect is a new technology emerged in recent ten years, which can control droplets with micro and nano liter volume on the plane. In order to meet the urgent needs of precise driving and control of droplets in the digital microfluidic, combined with the existing droplet positioning methods, an improved equivalent capacitance model was designed to locate multi droplets without input parameters. Based on the droplet positioning model, the feedback priority adjustment strategy of driving parameters was proposed. Finally, a digital microfluidic control system with driving, positioning and feedback was obtained. The experimental results show that the proposed scheme is helpful to improve the success rate of the continuous transport of micro droplets, the success rate increases by nearly 40% with the same chip parameter structure. It has certain guiding significance for the further application research of digital microfluidic systems.

Key words: electrowetting on dielectric (EWOD); digital microfluidic; equivalent capacitance model; feedback priority; precise driving and control

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Evaluation of the Transverse Anisotropy Response of High g Accelerometers by a Free Drop Bar Impact Method

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Abstract: A free drop bar impact method was used to investigate the transverse response of a cantilever beam high g accelerometer (50 000g). The steel bar and aluminum alloy bar were used as impactors to collide with the metal steel anvil placed on the ground to produce the stress wave. The performance of the accelerometer was characterized with the stress wave as an excitation source, meanwhile the accelerometer was attached at the top of the metal bar. This method not only can measure the sensitivity of the sensitive axis for the accelerometer, but also can test the transverse response. The experiment shows that the anisotropy response is closely related to the intrinsic structure of the accelerometer and the bar diameter. A good consistency between the experiment and calculation results was obtained.

Key words: transverse response; high g accelerometer; impact; physical effect; sensitivity

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高量程加速度计横向各向异性响应的

自由落杆冲击评估法

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摘要: 采用自由落杆冲击法对悬臂梁型高量程加速度计 (50 000g) 的横向响应进行研究。钢杆和铝合金杆作为冲击体与地面上放置的金属钢砧碰撞产生应力波作为激励源, 用于表征加速度计的性能, 其中加速度计固定在金属杆的顶端。该方法不仅可以测量加速度计敏感轴的灵敏度, 同时也可以测试其横向响应。实验表明, 加速度计的各向异性响应与加速度计的固有结构和冲击体的直径紧密相关, 理论计算与实验结果相一致。

关键词: 横向响应; 高量程加速度计; 冲击; 物理效应; 灵敏度

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集成式 MEMS 卩 FAIMS 分析器在线

快速检测不同标号汽油

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摘要: 车用汽油质量及泄漏问题严重影响人们的出行安全和生活环境。基于微电子机械系统 (MEMS) 工艺制备了高场不对称波形离子迁移谱 (FAIMS) 分析器, 提出了基于 FAIMS 峰位置差异的不同标号汽油一维在线检测方法和基于离子迁移率非线性变化函数的二维在线检测方法。结果表明, 分离电压范围 1 050~1 110 V 为三种标号汽油的最佳一维鉴别条件。在该分离条件下, 不同标号的汽油对应不同的峰位置。为进一步提高鉴别准确率, 通过求解离子迁移率非线性变化函数二阶和四阶系数 α_2 、 α_4 , 构建了不同标号汽油的二维识别方法。结果表明, 不同标号汽油的离子峰在 α_2 、 α_4 张成的平面内分布于不同的区域。该研究为不同标号汽油的快速鉴别及现场检测提供了技术支持。

关键词: 高场不对称波形离子迁移谱 (FAIMS); 微电子机械系统 (MEMS); 在线检测; 分析器; 准确率

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Rapid Identification and On Site Detection of Different Labeled Gasoline by the Integrated MEMS 卩 FAIMS

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Abstract: Gasoline quality and leakage seriously affect people's travel safety and living environment. The high 卩 field asymmetric waveform ion mobility spectrometry (FAIMS) analyzer was fabricated based on the micro 卩 electromechanical system (MEMS) process. A one 卩 dimensional on 卩 site detection method and a two 卩 dimensional on 卩 site detection method of different labeled gasolines were proposed, separately based on the difference of peak positions of FAIMS and the nonlinear change function of ion mobility. The results show that the separation voltage range of 1 050-1 110 V is the optimal one 卩 dimensional identification condition for three kinds of gasolines. The different labeled gasolines are corresponding to different peak positions under the separation condition. To further improve the identification accuracy, a two 卩 dimensional identification method for different labeled gasolines was constructed by solving the second 卩 order coefficient α_2 and fourth 卩 order coefficient α_4 of the nonlinear change function of ion mobility. The results show that ion peaks of different labeled gasolines are distributed in different regions in the plane formed by α_2 and α_4 . This study provides technical support for the rapid identification and on 卩 site detection of different labeled gasolines.

Key words: high 卩 field asymmetric waveform ion mobility spectrometry (FAIMS); micro 卩 electromechanical system (MEMS); on 卩 site detection; analyzer; accuracy

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纳米线距标准样片的研制和表征

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摘要: 论述了线距标准在扫描电子显微镜 (SEM) 类测量仪器校准中的重要性和作为标准物质的基本要求, 指出了纳米线距标准物质的研制和表征在纳米量值溯源体系中的重要作用。通过材料选择、结构设计和制作工艺优化研制出了线距标称值为 100 nm 的纳米线距标准样片。利用光学显微镜对样片的表面质量进行初检, 利用 CD Ⅱ SEM 对样片的表征考核区域进行了均匀性和长期稳定性的测量以及对线距尺寸进行定值, 同时对测量结果进行计算分析。实验结果表明, 研制的 201710001 纳米线距标准样片的对比度良好、线条平直, 均匀性和稳定性均小于 2 nm, 且线距尺寸具有溯源性, 可作为校准 SEM 类测量仪器图像放大倍率和图形畸变的标准物质使用。

关键词: 纳米线距; CD Ⅱ SEM; 制作工艺; 质量参数; 均匀性; 稳定性

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Development and Characterization of Nanolattice

Pitch Standard Sample

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Abstract: The importance of the pitch standard in calibration of the scanning electron microscope (SEM) measuring instruments and the essential requirement as the standard substance were introduced. The important role of the preparation and characterization of the nanolattice pitch standard substance in the nanometer valuation traceability system was pointed out. The nanolattice pitch standard sample with a lattice pitch nominal value of 100 nm was developed through the material selection, structural design and manufacturing process optimization. The surface quality of the nanolattice pitch standard sample was initially examined by optical microscope. Through the CD Ⅱ SEM, the uniformity and long term stability were measured in the examination areas of the pitch standard sample and the pitch value was determined. Meanwhile, the measurement results were calculated and analyzed. The experimental results show that the developed 201710001 nanolattice pitch standard sample has good contrast and straight lines, the uniformity and stability of the standard sample are both less than 2 nm, and the pitch size has traceability. The 201710001 nanolattice pitch standard sample can be used as the standard substance to calibrate the image magnification and distortion of the SEM measuring instruments.

Key words: nanolattice pitch; CD Ⅱ SEM; manufacturing craft; quality parameter; uniformity; stability

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接触式轮廓仪探针状态检查图形样块的研制

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摘要: 针对接触式轮廓仪存在的探针沾污、探针缺陷、扫描位置不准的问题, 采用半导体工艺技术在硅晶圆片上制备出探针状态检查样块。该样块具有探针沾污及缺陷检查图形和探针扫描位置检查图形, 可实现探针针尖 10 个位置沾污和缺陷的检查以及偏移量为 $-150\sim 150\ \mu\text{m}$ 内探针扫描位置的检查。使用探针状态检查样块对一台型号为 P-6 的接触式轮廓仪进行了检查, 实验结果表明: 该样块能够准确判断出轮廓仪存在探针缺陷和扫描位置不准的问题, 进而有助于接触式轮廓仪探针的故障检查和维修。

关键词: 轮廓仪; 探针沾污; 探针缺陷; 扫描位置; 检查图形

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Development of the Inspection Pattern Specimen for the
Contact Profiler Stylus State

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Abstract: In order to resolve the problems of stylus contamination, stylus defects and inaccurate scanning position in the stylus profiler, a stylus state inspection specimen was prepared on the silicon wafer using the semiconductor process technology. The specimen had a stylus contamination and defect inspection pattern and a stylus scanning position inspection pattern, which could inspect the contamination and defects of the stylus tip at 10 positions, and the stylus scanning position in the offset range from $-150\ \mu\text{m}$ to $150\ \mu\text{m}$. A contact profiler of type P-6 was inspected using the stylus state inspection specimen. The experimental results show that the specimen can accurately determine the problems of stylus defects and inaccurate scanning position of the profiler, which facilitates fault inspection and repair of the contact profiler stylus.

Key words: profiler; stylus contamination; stylus defect; scanning position; inspection pattern

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