

基于硅透镜集成的高灵敏度室温太赫兹探测器

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摘要: 提出了一种基于硅透镜集成的高灵敏度 GaN/AlGaIn 高电子迁移率晶体管 (HEMT) 的太赫兹模组探测器。在太赫兹波辐照下, 超半球硅透镜可以有效提高太赫兹波收集效率和消除被测器件的衬底干涉效应, 进而提高探测器的灵敏度。对集成有直径为 6 mm 超半球硅透镜的太赫兹探测器件进行了仿真和测试。研究发现在频率为 600 和 900 GHz 的太赫兹波辐照下, 硅透镜中心区域的太赫兹电场分别增加到原来的 5~9 倍和 6~8 倍。在 300 K 下器件的响应度和噪声等效功率分别为 4~5 kV/W 和 30 pW/Hz^{0.5}, 在 77 K 下器件的响应度达到 100 kV/W, 噪声等效功率降至 1 pW/Hz^{0.5}。

关键词: 探测器; 太赫兹; 高电子迁移率晶体管 (HEMT); 硅透镜; 灵敏度

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High Sensitivity Room Temperature Terahertz Detector

Based on Silicon Lens Integration

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Abstract: A high sensitivity GaN/AlGaIn high electron mobility transistor (HEMT) terahertz module detector based on the silicon lens integration was proposed. Under terahertz wave irradiation, the terahertz wave collection efficiency was improved effectively and the substrate interference effect of the measured device was eliminated effectively by the ultra hemispherical silicon lens, then the sensitivity of the detector was improved. The simulation and test of the terahertz detector integrated ultra hemispherical silicon lens with a diameter of 6 mm were carried out. The research result shows that under terahertz wave irradiation with two frequencies of 600 and 900 GHz, the electric field of the silicon lens central area increase by 5~9 times and 6~8 times, respectively. The responsivity and noise equivalent power of the device are 4~5 kV/W and 30 pW/Hz^{0.5} respectively at 300 K. The responsivity of the device reaches 100 kV/W and the noise equivalent power decrease to 1 pW/Hz^{0.5} at 77 K.

Key words: detector; terahertz; high electron mobility transistor (HEMT); silicon lens; sensitivity

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基于自支撑 GaN 和蓝宝石衬底 AlGaIn/GaN

MISHEMT 器件对比

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摘要: 通过金属有机化学气相沉积(MOCVD)法, 在氢化物气相外延 (HVPE) 自支撑 GaN 衬底和蓝宝石(0001)衬底上外延生长 AlGaIn/AlN/GaN 结构的高电子迁移率晶体管(HEMT)材料, 采用低压化学气相沉积 SiNx 作为栅介质层, 形成金属绝缘半导体高电子迁移率晶体管(MISHEMT)结构, 对比研究了两种器件的材料性能和电学特性。阴极发光测试表明 HVPE 的自支撑 GaN 衬底缺陷密度可降至 $6 \times 10^5 \text{ cm}^{-2}$ 量级。自支撑 GaN 衬底上 AlGaIn/GaN HEMT 结构具有良好的表面形貌, 其表面粗糙度 Ra 仅为 0.51 nm, 具有较大的源漏电极饱和电流 $I_{DS}=378 \text{ mA/mm}$ 和较高跨导 $G_m=47 \text{ mS/mm}$ 。动态导通电阻测试进一步表明, 自支撑 GaN 衬底上同质外延生长的 GaN 缓冲层具有低缺陷密度, 使 AlGaIn/GaN MISHEMT 电流崩塌特性得到抑制。

关键词: 氢化物气相外延 (HVPE) GaN 衬底; 金属有机化学气相沉积(MOCVD); AlGaIn/GaN 金属绝缘半导体高电子迁移率晶体管(MISHEMT); 同质外延; 电流崩塌

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Comparison of AlGaIn/GaN MISHEMTs on Free Standing

GaN and Sapphire Substrates

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Abstract:By the metal organic chemical vapor deposition (MOCVD) method, an AlGaIn/GaN structure of high electron mobility transistors (HEMTs) was grown on free standing GaN and sapphire (0001) substrates by hydride vapor phase epitaxy (HVPE). With SiNx grown by the low pressure chemical vapor deposition as gate dielectric layer, the metal insulator semiconductor high electron mobility transistor (MISHEMT) structure was prepared. The material and electrical properties of two kinds of the devices were compared. The cathodoluminescence test result shows that the defect density of the HVPE free standing GaN substrate can reduce to $6 \times 10^5 \text{ cm}^{-2}$. The AlGaIn/GaN HEMT structure grown on the free standing GaN substrate has a smooth surface morphology with a surface roughness Ra of 0.51 nm, large saturation current of source and drain electrode of $I_{DS}=378 \text{ mA/mm}$ and large transconductance $G_m=47 \text{ mS/mm}$. The dynamic on resistance measurements result indicates that the homoepitaxy GaN buffer layer on the free standing GaN substrate has low defect density, and then the current collapse characteristic of the AlGaIn/GaN MISHEMT is suppressed.

Key words:hydride vapor phase epitaxy (HVPE) GaN substrate; metal organic chemical vapor deposition (MOCVD); AlGaIn/GaN metal insulator semiconductor high electron mobility transistor(MISHEMT); homoepitaxy; current collapse

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ZnSe : O/ZnO 核壳结构纳米线中间带

太阳电池的设计

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摘要: 为了得到 ZnSe : O/ZnO 核壳结构纳米线中间带太阳电池的最优吸收效率, 通过时域有限差分法对纳米线的直径进行了优化, 使纳米线的吸收光谱与太阳光谱相重合的波段有较高的吸收效率, 并且使 ZnSe : O/ZnO 纳米线的吸收光谱在带边和中间带有共振模式, 从而使中间带太阳电池的吸收效率在 ZnSe : O 的带边和中间带是最大的。为了进一步提高中间带的吸收效率, 通过在纳米线两侧制备圆柱形铝天线的方法, 利用金属铝天线的局域表面等离子体共振, 使中间带太阳电池在中间带的吸收效率进一步增强到近两倍。这种方法为制备高性能的太阳电池和光探测器等光电器件开辟了新的途径。

关键词: 中间带太阳电池; ZnSe : O/ZnO 核壳结构纳米线; 时域有限差分法; 光吸收效率

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Design of ZnSe : O/ZnO Core/Shell Nanowire

Intermediate Band Solar Cells

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Abstract: For achieving an optimal absorption efficiency of ZnSe : O/ZnO core/shell nanowire intermediate band solar cells, the diameter of the nanowire was optimized using the finite difference time domain method, the higher absorption efficiency was obtained in the wave band of the nanowire absorption spectrum coinciding with the solar spectrum, and the absorption spectra of ZnSe : O/ZnO nanowires was in resonant mode at the band edge and intermediate band, then the absorption efficiency of the intermediate band solar cells was the largest at the band edge and the intermediate band of ZnSe : O. In order to further improve the absorption efficiency of the intermediate band, the cylinder aluminum antennas were fabricated on both sides of the nanowire, by using the local surface plasmon resonance of the metal aluminum antennas, the absorption efficiency of the intermediate band solar cell was enhanced to about two times in the intermediate band. This approach opens a new way for the fabrication of high performance optoelectronic devices such as solar cells and photodetectors.

Key words: intermediate band solar cell; ZnSe : O/ZnO core/shell nanowire; finite difference time domain method; optical absorption efficiency

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石墨烯/金属接触研究进展

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摘要: 石墨烯/金属接触是石墨烯应用在集成电路领域的一个重要问题, 按照其接触方式的不同, 介绍了近年来关于石墨烯/金属接触的研究, 主要分析了面接触与边缘接触的接触机理以及不同接触方式的器件结构, 比较了各种接触方式的优劣。由于金属与石墨烯的电流主要通过边缘传输, 通过在石墨烯与金属的接触界面引入边缘接触, 增加了电流流经的路径, 从而减小石墨烯与金属的接触电阻率。最后总结出边缘接触是最可能优化其接触电阻率的技术方案, 并展望了石墨烯/金属接触的研究前景。

关键词: 石墨烯; 金属; 面接触; 边缘接触; 欧姆接触; 二维材料

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Research Progress of Graphene/Metal Contact

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Abstract: Graphene/metal contact is an important issue for graphene application in the field of integrated circuits. The recent studies of the graphene/metal contact are introduced in accordance with the different contact modes. The contact mechanisms of the surface contact and edge contact and the device structures of different contact modes are mainly analyzed, and the advantages and disadvantages for various kinds of contact modes are compared. At the interface between the metal and graphene, the current is mainly transmitted through the edge, so by introducing edge contacts at the contact interface between graphene and metal, the paths of the current flow increase, thereby the contact resistivity between graphene and metal decreases. Finally, it is concluded that the edge contact is the most likely technical scheme to optimize the contact resistivity, and the research prospect of the graphene/metal contact is provided.

Key words: graphene; metal; surface contact; edge contact; ohmic contact; two dimensional material

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设计和工艺参数对声表面波器件性能的影响

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摘要: 设计并制作了多种声表面波 (SAW) 器件, 并研究了设计参数与工艺参数对器件特性的影响。首先在同一块掩模板内设计了多组不同尺寸与间距参数的 SAW 器件, 然后用微电子机械系统 (MEMS) 微加工工艺在 $Mg_xZn_{1-x}O/Si$ 压电薄膜和 128° YZ 与 XZ 取向的 $LiNbO_3$ 压电材料衬底上制作了多种 SAW 器件。利用 X 射线衍射 (XRD) 对压电材料的压电晶向进行了测量、表征和工艺比较, 确定了适宜的薄膜溅射条件。利用网络分析仪 (VNA) 及高频探针台测量了 S_{11} 高频特性, 测量结果表明相对应的谐振频率值与理论值相符合, 测出的谐振频率在 $80\sim 330$ MHz。分析了工艺偏差对 SAW 器件谐振特性的影响。分析结果表明由于工艺偏差导致的叉指电极的指宽差异导致了谐振频率与理想计算值的偏差, 工艺偏差同样会导致 S_{11} 曲线的不对称和谐波的产生。通过 $LiNbO_3$ 上制作的 SAW 器件计算出的声波传播速度比较统一, 128° YX $LiNbO_3$ 上制作的 SAW 器件计算出的声波传播速度为 $3\ 800\sim 3\ 900$ m/s, XZ $LiNbO_3$ 上制作的 SAW 器件计算出的声波传播速度为 $3\ 300\sim 3\ 400$ m/s; 而在 $Mg_xZn_{1-x}O/Si$ 压电薄膜上制作的 SAW 器件推算出的声波传播速度与设计波长或相关尺寸有关。

关键词: 声表面波 (SAW) 器件; 压电薄膜; 射频器件; 谐振频率; 回波损耗

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Effects of Design and Process Parameters on Performances of
Surface Acoustic Wave Devices

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Abstract: Varieties of surface acoustic wave (SAW) devices were designed and fabricated. The effects of design and process parameters on the device performances were studied. Firstly, several groups of the SAW devices with different sizes and gap distances were designed on the same mask, and then were fabricated on the $Mg_xZn_{1-x}O/Si$ piezoelectric thin film and $LiNbO_3$ piezoelectric material substrate with 128° YZ orientation and XZ orientation by the microelectromechanical system (MEMS) microfabrication technology. The piezoelectric crystal orientation of the piezoelectric materials were measured, characterized and compared from the process by X-ray diffraction (XRD) to determine the suitable sputtering conditions of the thin film. Using a virtual network analyzer (VNA) and high frequency probe station, the high frequency characteristics S_{11} of the SAW devices were measured. The measurement results show that the measured resonant frequency is $80\sim 330$ MHz and nearly consistent with the theoretical corresponding value. The effect of the process deviation on the resonance characteristic of the SAW device was analyzed. The results show that the finger width difference of interdigital electrodes caused by the process deviation results in the deviation between the resonant frequency and ideal calculation value, and the process deviation also lead to the asymmetry of S_{11} curves and harmonic wave generation. The acoustic velocities calculated by SAW devices on $LiNbO_3$ substrates are relatively uniform, the acoustic velocities calculated by SAW devices on 128° YX $LiNbO_3$ and XZ $LiNbO_3$ substrates are $3\ 800\sim 3\ 900$ m/s and $3\ 300\sim 3\ 400$

m/s, respectively. The acoustic velocity calculated by the SAW device fabricated on $Mg_xZn_{1-x}O/Si$ piezoelectric thin films is related to design wavelength or relative size.

Key words:surface acoustic wave (SAW) device; piezoelectric thin film; RF device; resonant frequency; return loss

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一款基于 MEMS 工艺的超宽带八边形
缝隙柔性天线

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摘要: 设计了一款小型超宽带(UWB)共面波导(CPW)馈电的八边形缝隙柔性天线, 可应用于超宽带无线通信系统。该天线采用了新兴柔性材料聚二甲基硅氧烷(PDMS)作为介质基板, 并在 PDMS 介质基板的一侧单面覆铜, 设计了八边形辐射单元结构和具有八边形缝隙的金属地。为降低工艺难度、简化工艺流程, 采用了共面波导进行馈电, 并设计了具有阻抗线性渐变功能的梯形结构的信号导带。利用电磁仿真软件对天线进行仿真优化, 基于微电子机械系统(MEMS)工艺对天线进行加工制作, 并进行了测试。结果表明, 所设计的天线带宽达到了 11~40 GHz (3~14~50 GHz), 阻抗相对带宽约为 130%, 频带内电压驻波比小于 2, 阻抗匹配良好。测试结果与仿真结果基本一致, 天线实现了超宽带工作性能。

关键词: 超宽带(UWB); 共面波导(CPW); 八边形缝隙天线; 柔性; 微电子机械系统(MEMS)

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An Ultra Wideband and Flexible Octagon Slot Antenna
Based on MEMS Technology

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Abstract: A compact ultra wideband (UWB) and flexible octagon slot antenna fed by coplanar waveguide (CPW) was designed, which can be applied to ultra wideband wireless communication systems. The burgeoning flexible material polydimethylsiloxane (PDMS) was adopted as the dielectric substrate of the antenna, and copper was covered only on one side of the PDMS dielectric substrate, then an octagon radiation unit and a metal ground plane with an octagon slot were fabricated. In order to reduce the technical difficulty and simplify the process flow, the coplanar waveguide was used to feed the antenna, and the trapezoidal frame signal conduction band with impedance linear gradient function was designed. The antenna was simulated and optimized by the electromagnetic simulation software. The antenna was fabricated based on micro electromechanical system (MEMS) technology and then measured. The results show that the bandwidth of the designed antenna reaches 11~40 GHz (3~14~50 GHz), the impedance relative bandwidth is about 130%, the voltage standing wave ratio in the frequency band is less than 2, the impedance matching is good. The measured results are mainly consistent with the simulated results, and the ultra wideband working performance of the antenna is realized.

Key words: ultra wideband (UWB); coplanar waveguide (CPW); octagon slot antenna; flexibility; micro electromechanical system (MEMS)

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基于摩擦和压电复合机制的接触-分离式 纳米发电机

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摘要:介绍了一种基于摩擦和压电复合机制的接触-分离式纳米发电机的制备方法, 利用倒模工艺形成带有铜网微结构的硅胶膜, 与铝电极形成顶端摩擦层结构; 利用聚偏氟乙烯 (PVDF) 膜和铝电极形成底端压电层结构, 其中中间铝电极为共享电极, 使摩擦单元和压电单元协同工作。研究表明, 摩擦单元和压电单元在接触-分离的周期过程中产生的电信号不同步, 需要分别对它们进行整流后混合输出。摩擦单元整流后的电压峰值约为 100 V, 压电单元整流后的电压峰值约为 50 V, 整流后混合输出的电能能够点亮 50 盏 LED 灯, 存储在电容中能够为电子表正常工作持续供电, 因此, 复合纳米发电机可以作为振动能量采集器被广泛应用。

关键词:摩擦纳米发电机; 压电纳米发电机; 接触-分离; 复合机制; 整流

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A Contact Separation Type Nanogenerator Based on Triboelectric and Piezoelectric Hybrid Mechanism

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Abstract:A fabrication method of a contact separation type nanogenerator based on triboelectric and piezoelectric hybrid mechanism was proposed. The top triboelectric layer was fabricated using aluminum electrodes and silicone rubber film with copper net micro structure formed by the reverse mould technology. The bottom piezoelectric layer was fabricated using polyvinylidene fluoride (PVDF) film and aluminum electrodes, and the middle aluminum electrode was the shared electrode to realize the cooperative work between the triboelectric unit and piezoelectric unit. The study results show that the electrical signals produced by the triboelectric unit and piezoelectric unit in the periodic process of contact separation are not synchronized, so they need to be rectified and mixed to output respectively. The rectified voltage peak value of the triboelectric unit is about 100 V, the rectified voltage peak value of the piezoelectric unit is about 50 V. The mixed rectified output electrical energy can light up 50 LED lights, and can be stored in the capacitors to provide continuous power for normal working of the electronic meter. Therefore, the hybrid nanogenerator can be widely used as a vibration energy harvester.

Key words:triboelectric nanogenerator; piezoelectric nanogenerator; contact separation; hybrid mechanism; rectification

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微半球谐振陀螺技术研究进展

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摘要: 首先介绍了微半球谐振陀螺(μ HRG)基于驻波进动效应进行角度或角速度检测的工作原理。依据谐振子制作工艺的区别, 将微半球谐振陀螺分为微玻璃吹制型、牺牲层型、精加工型三种, 并对上述三种类型微半球谐振陀螺的加工工艺方案及特点、谐振子尺寸、陀螺或谐振子性能参数的国内外研究成果进行了详细阐述。简要对比分析了三种类型微半球谐振陀螺的优缺点, 如潜在精度、体积、成本、与 IC 可集成性、批量化前景等, 指出了微半球谐振陀螺目前面临的主要工艺技术问题, 并针对此从工艺方案设计、工艺参数优化等方面提出了一些可能的技术解决途径。

关键词: 微半球谐振陀螺(μ HRG); 玻璃吹制; 牺牲层; 精加工; Q 值; 各向同性刻蚀

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Research Development of Micro Hemispherical Resonator

Gyro (μ HRG) Technology

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Abstract: Firstly, the working principle for the angular measure or tachometric survey of micro hemispherical resonator gyros (μ HRGs) is introduced based on the standing wave precession effect. According to the difference of processing technology, the μ HRGs are divided into three types, i. e. micro glassblowing type, sacrificial layer type and precision machining type. The domestic and foreign research results of the three types of the μ HRGs are illustrated in detail, including the machining process scheme and feature, resonator size, gyro or resonator performance parameters. The advantages and disadvantages of the three types of the μ HRGs are briefly compared and analyzed, such as accuracy, volume, cost, integration with ICs and batch production prospect. Several main process issues of the μ HRGs are pointed out, and the possible technical solutions are presented from the aspects of the process scheme design and optimization of process parameters.

Key words: micro hemispherical resonator gyro (μ HRG); glassblowing; sacrificial layer; precision machining; Q factor; isotropic etching

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基于阴离子表面活性剂的铜 CMP 后
清洗新型碱性清洗液

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摘要: 铜布线化学机械抛光(CMP)后清洗的主要对象是 CMP 工艺后在铜表面的残留物, 包括硅溶胶颗粒、金属离子与有机物残留。采用 PVA 刷洗的清洗方式对 CMP 后表面残留的硅溶胶颗粒与表面吸附的苯并三氮唑(BTA)的去除进行了实验研究。通过原子力显微镜(AFM)和接触角测量仪对两种阴离子表面活性剂(十二烷基苯磺酸(LABSA)和脂肪醇聚氧乙烯醚硫酸铵(AESA))与 FA/O 型非离子表面活性剂在碱性环境中对硅溶胶颗粒及 BTA 的去除效果进行分析表征, 并对去除效果进行了对比。实验得出此两种阴离子表面活性剂在较低质量分数下就能达到 FA/O 型非离子表面活性剂在高质量分数下才有的颗粒去除效果。AESA 在质量分数为 0.05% 时配合质量分数为 0.015% 的 FA/O II 型螯合剂不仅能有效去除晶圆表面沾污的硅溶胶颗粒, 同时能有效去除表面沾污的 BTA。

关键词: 阴离子表面活性剂; 碱性清洗液; 硅溶胶颗粒; 苯并三氮唑(BTA); 化学机械抛光(CMP)后清洗

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A Novel Alkaline Cleaning Solution for Post Cu CMP Cleaning

Based on Anionic Surfactant

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Abstract: The major objects of the copper wiring post chemical mechanical polishing (CMP) cleaning are residues on the copper surface after CMP, such as silica sol particles, metallic ions and organic residues. The removals of the surface residual silica sol particles and benzotriazole(BTA) contamination absorbed on the surface was experimentally studied by using the PVA brush scrubber cleaning method. The silica sol particles and BTA removal effects of two different anionic surfactants (linear alkylbenzenesulfonic acid (LABSA) and ammonium fatty alcohol polyoxyethylene sulfate (AESA)) and FA/O nonionic surfactant in alkaline environment were characterized by the atomic force microscopy (AFM) and angle contact meter, and the removal effects were compared. The experimental results show that the two anionic surfactants at low mass fraction can achieve the particle removal effect as that of FA/O nonionic surfactant at high mass fraction. The silica sol particles on the wafer surface can be removed effectively using AESA with the mass fraction of 0.05% and FA/O II chelating agent with the mass fraction of 0.015%, and the BTA contamination can also be removed effectively.

Key words: anionic surfactant; alkaline cleaning solution; silica sol particle; benzotriazole(BTA); post chemical mechanical polishing(CMP) cleaning

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柔性基底导电银墨水喷墨打印工艺分析

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摘要: 以银导电墨水为打印墨水材料, 以热塑性聚氨酯弹性体橡胶 (TPU) 薄膜为柔性基底材料, 通过压电式材料喷墨打印机在柔性基底上打印导电膜图形。通过光学显微镜对基底材料表面打印银墨水状态观察发现: 基底表面亲水处理可以有效提高基底对银墨水的吸附力; 柔性薄膜适当的预拉伸有利于提高薄膜平整度, 提高墨水打印导电膜图形的质量; 墨滴质量、喷嘴状态及喷嘴和基底薄膜的间隙校正是保证打印均匀性的关键; 在烧结工艺中, 采用逐渐提高温度的方式, 可达到逐渐释放热应力的目的, 减少由于温度剧变对 TPU 薄膜表面银墨图形结构产生变形或龟裂的现象, 可有效地提高烧结后所形成导电图案的完整性和连续性。

关键词: 喷墨打印; 银墨水; 柔性基底; 薄膜; 烧结

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Inkjet Printing Process Analysis of Conductive Silver

Ink on Flexible Substrates

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Abstract: Conductive film pattern was printed on the flexible substrate through the piezoelectric material inkjet printer with the conductive silver ink as printing ink material and the thermoplastic polyurethanes (TPU) film as flexible substrate material. The state of the printed silver ink on the substrate surface was observed through the optical microscope. It is found that the hydrophilic treatment on the substrate surface can effectively improve the adsorbability of the substrate for the silver ink. The appropriate pre stretching of the flexible film is helpful to improve the smoothness of the film and the printed quality of the ink transformed into the conductive film pattern. The ink drops quality, nozzle state and correction of the clearance between the nozzle and substrate film are the keys to guarantee the printing uniformity. The method of gradually increasing temperature in the sintering process can achieve the goal of gradually releasing the thermal stress, reduce the deformation or cracking phenomenon of the silver ink pattern structure on the surface of the TPU film caused by temperature drastic change, and effectively improve the integrity and continuity of the sintered conductive pattern.

Key words: inkjet printing; silver ink; flexible substrate; thin film; sintering

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基于螯合剂与活性剂的 Cu CMP 清洗液对
BTA 去除的影响

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摘要: 以螯合剂与活性剂为材料, 利用难溶物质微弱电离平衡、螯合剂络合机理以及活性剂的铺展、润湿以及渗透作用, 结合有机物结构相似相溶原理, 研制新型碱性清洗液, 用于有效去除 Cu CMP 后的苯并三氮唑 (BTA)。通过接触角测试、电化学实验以及原子力显微镜 (AFM) 测试可以得出: 体积分数为 0.015% 的 FA/O II 螯合剂、体积分数为 0.003% 的 FA/O I 螯合剂与体积分数为 0.1% 的 FA/O 活性剂组成的新型碱性清洗剂, 采用清洗液体积流量为 1.440 mL/min 进行 PVA 刷洗, 可以有效去除 BTA, 且具有较低的表面粗糙度和较高的表面耐腐蚀性。螯合剂既可以与 Cu BTA 反应生成铜胺络离子去除 BTA, 也可作为催化剂, 提高活性剂在 Cu 表面的铺展、润湿及渗透效果, 进一步增强 BTA 的去除效果。

关键词: CMP 后清洗; BTA 去除; 螯合剂; 活性剂; 表面粗糙度

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Effect of Chelating Agent and Surfactant Based Cu CMP

Cleaning Solution on BTA Removal

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Abstract: Using weak ionization equilibrium of insoluble materials, chelating agent complexation mechanism, and spreading, wetting and penetration of surfactants, combining the principle of organic structure similarity and miscibility, a novel alkaline cleaning solution based on chelating agent and surfactant was prepared to effectively remove benzotriazole (BTA) after Cu CMP. The results of the contact angle measurement, electrochemical experiment and atomic force microscope (AFM) test show that the novel alkaline cleaning solution composed of FA/O II chelating agent with volume fraction of 0.015%, FA/O I chelating agent with volume fraction of 0.003% and FA/O surfactant with volume fraction of 0.1% can effectively remove BTA by PVA scrub when the volume flow of the cleaning solution is 1.440 mL/min, and lower surface roughness and higher surface corrosion resistance are obtained. The chelating agent not only can react with Cu BTA to generate copper amine complex ion for BTA removal, but also can be used as catalyst to improve the spreading, wetting and penetration effects of the surfactant on Cu surface, and then further enhance the removal effect of BTA.

Key words: post CMP cleaning; BTA removal; chelating agent; surfactant; surface roughness

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GaSb 单晶片 CMP 工艺的研究

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摘要: 主要研究了 GaSb 单晶片的化学机械抛光 (CMP)。使用硅溶胶作为抛光液对切割、机械抛光后的 GaSb 单晶片进行了 CMP 实验。在实验中, 通过调节抛光液配比、pH 值等工艺参数, 研究不同氧化剂的掺入以及抛光液不同 pH 值对 GaSb 单晶片表面的影响。通过实验得出, 最终在 pH 值为 8 且使用 NaClO 作为氧化剂的条件下, 得到平整度较好、表面缺陷少、表面粗糙度低的高质量抛光表面的 GaSb 单晶片。通过微分干涉显微镜观察抛光后的单晶片表面无明显缺陷。经原子力显微镜 (AFM) 测试, 单晶片的表面粗糙度达到了 0.257 nm。

关键词: GaSb; 化学机械抛光 (CMP); 表面粗糙度; pH 值; 氧化剂

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Research on the CMP Process of the GaSb Single Crystal Wafer

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Abstract: The chemical mechanical polishing (CMP) of the GaSb single crystal wafer was mainly studied. Using the silica sol as polishing solution, the CMP experiment of the GaSb single crystal wafer after cutting and mechanical polishing was carried out. In the experiment, the influences of different oxidizing agent incorporation and different pH values of the polishing solution on the GaSb single crystal wafer surface were studied by adjusting the polishing solution proportion, pH value and other process parameters. The experimental results show that when the pH value is 8 and NaClO is used as oxidizing agent, the GaSb single crystal wafers with high quality polishing surface, such as good flatness, less surface defects and low surface roughness, are finally obtained. By the differential interference microscope, it is observed that the surface of the polished single crystal wafer has no obvious defect. The atomic force microscope (AFM) test result shows that the surface roughness of the single crystal wafer reaches 0.257 nm.

Key words: GaSb; chemical mechanical polishing (CMP); surface roughness; pH value; oxidizing agent

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