

# 2005年微电子学研究所发表的学术论文

## 一、微纳器件与系统研究室

### 1、分子电子学

董浩, 邓宁, 陈培毅

世界科技研究与发展, Vol 27, No.3, 2005, p1-6

作为纳米电子学的一个重要分支,分子电子学在近年来得到了巨大的发展,并成为国际上研究的热点。本文介绍了各种分子器件的制作技术及基本工作原理,回顾了近年来分子电子学的最新进展,展望了分子电子学的未来发展。

#### Molecular electronics

Dong Hao, Deng Ning and Chen Peiyi

World Sci-Tech R&D, Vol.27, No.3, 2005, p1-6

As one of the most important parts of nanoelectronics, molecular electronics have attracted more and more attentions and developed significantly. This paper introduces the fabrication technology and the basic principle of molecular devices. The latest developments of the molecular electronics are reviewed as well. Finally, the further trends are also discussed.

### 2、电子辐照SiGe HBT和Si BJT直流特性分析

黄文韬, 邓宁, 陈培毅, 罗广礼, 钱佩信

核技术, Vol.28, No.3, 2005, p213-216

研究了1 MeV 不同剂量电子辐照前后SiGe 异质结晶体管(HBT)的直流特性,并与Si 双极晶体管(BJT)进行了比较。结果表明辐照后SiGe HBT 的 $I_B$ 基本不变, $I_C$ 和 $\beta$ 都下降;随电子辐照剂量的增加, $I_C$ 和 $\beta$ 都减小。对Si BJT而言, $I_B$ 和 $I_C$ 与在相同辐照剂量辐照后的SiGe HBT 相比都增大很多, $\beta$ 下降幅度也很大。这说明SiGe HBT 具有比Si BJT 更好的抗辐照性能。对电子辐照后器件电学性能的变化机制进行了初步分析。

#### Electrical performance analysis of electron irradiated SiGe HBT and Si BJT

Wentao Huang, Ning Deng, Peiyi Chen, Guangli Luo, Pei-Hsin Tsien

Nuclear Technique, Vol.28, No.3, 2005, p213-216

The change of electrical performances of 1 MeV electron irradiated silicon-germanium (SiGe) heterojunction bipolar transistor (HBT) and Si bipolar junction transistor (BJT) was studied. After electron irradiation, the collector current  $I_C$  decreased while the base current  $I_B$  did not change, and the current gain  $\beta$  decreased for SiGe HBT. For conventional Si BJT, both  $I_C$  and  $I_B$  increased and  $\beta$  decreased much more obviously than SiGe HBT at the same fluence. It was shown that SiGe HBT had a better anti-radiation performance than Si BJT. The mechanism of electrical performance changes induced by irradiation was preliminarily discussed.

### 3、介观系统中的电导量子化

任敏, 陈培毅

微纳电子技术, Vol.42, No.2, 2005, p49-54.

对介观系统电子输运性质的研究是当前凝聚态物理研究中的活跃领域。介观尺度下,由于量子力学效应,出现了一些特殊的物理现象,如电导量子化。本文从理论和实验两方面对介观输运领域的研究情况作了简要回顾,介绍了一些较新的研究成果,并讨论了电导量子化在下一代集成电路中可能的应用方向。

#### Quantized Conductance in Mesoscopic System

Ren Min, Chen Peiyi

Micronanoelectronic Technology, Vol.42, No.2, 2005, p49-54

Electronic transport properties in mesoscopic systems have been an area of active research in condensed matter physics. Owing to quantum-mechanical effects, some strange physical phenomena appear, such as quantized conductance. This review is intended as an introduction to electronic transport properties in mesoscopic systems. It introduces an investigation of the mechanism of quantized conductance. Then, some representative experiments in this domain are presented. Lastly, an outlook on future applications in next generation integrated circuits is discussed.

### 4、基于Si/SiGe的空穴型共振隧穿二极管的研制及其电流方程参数提取

熊晨荣, 王燕, 陈培毅, 余志平

清华大学学报, Vol.45, No.1, (2005), p133-136

共振隧穿二极管因其特有的负微分电阻特性,成为一种很有前途的基于能带工程的异质结构量子器件。采用超高真空外延技术,以p型重掺杂硅为衬底生长出以4 nm 厚 $\text{Si}_{0.6}\text{Ge}_{0.4}$ 层为空穴量子阱、以4 nm 厚Si 层为空穴势垒的双势垒单量子阱结构。然后用常规半导体器件工艺制成了空穴型共振隧穿二极管。在室温下对面积为 $8\text{ }\mu\text{m}\times 8\text{ }\mu\text{m}$ 的共振隧穿二极管进行测量,其峰值电流密度为 $45.92\text{ kA/cm}^2$ ,电流峰谷比为2.21。根据测量得到的电流电压特性考虑串联电阻的影响,提取出共振隧穿二极管的直流参数。可以利用这些参数将共振隧穿二极管的直流模型加入SPICE 电路模拟软件器中进行共振隧穿二极管电路设计。

### Si/SiGe-based p-well Resonant tunneling diode and the DC-parameter extraction of RTD

Chenrong Xiong, Yan Wang, Peiyi Chen, Zhiping Yu

Journal of Tsinghua University Science and Technology, Vol.45, No.1, (2005), p133-136

▣ The resonant tunneling diode (RTD) is one of the most promising bandgap engineered heterostructure devices due to its negative differential resistance. A double-barrier-single-well structure with a 4 nm Si<sub>0.6</sub>Ge<sub>0.4</sub> hole quantum well and a 4 nm Si hole barrier was grown on a p+-Si substrate using ultrahigh vacuum chemical vapor deposition technology. A p-well resonant tunneling diode was then successfully fabricated with conventional semiconductor technology. A peak-current density of 45.92 kA/cm<sup>2</sup> and a peak to valley current ratio of 2.21 were obtained at room temperature for a 8μm × 8μm RTD sample. The effect of the series resistance was used to extract the DC parameters for the RTD from the current-voltage relationship. The DC model of the RTD can then be incorporated into a SPICE-like simulator to simulate RTD-based circuits.

### 5、介质上电润湿液滴驱动的研究

吴建刚 岳瑞峰 曾雪峰 刘理天

中国机械工程, Vol.16, No.14, 2005

▣ 制备了介质上电润湿 (Electrowetting-on-dielectric, EWOD) 液滴驱动器, 它采用“三明治”结构: 下极板由Ti/Pt微电极阵列、Si<sub>3</sub>N<sub>4</sub>介质薄膜、碳氟聚合物疏水薄膜组成; 上极板是覆盖有疏水薄膜的透明电极; 液滴被夹在上下电极之间。本文分析了驱动器的驱动原理、驱动阻尼以及介质层捕获电荷的影响, 并讨论硅油填充三明治结构和空气填充三明治结构两者的差异。

### Research of Electrowetting-on-Dielectrics Actuation

WU Jian-gang, YUE Rui-feng, ZENG Xue-feng, LIU Li-tian

China Mechanical Engineering, Vol.16, No.14, 2005

▣ A prototype of an electrowetting-on-dielectrics actuator is presented, consisting of two parallel plates and a sandwiched droplet. The bottom plate consists of Ti/Pt as the microelectrode array, a Si<sub>3</sub>N<sub>4</sub> film as the dielectric layer and a fluorocarbon polymer film as the hydrophobic layer. The top plate consists of a fluorocarbon polymer film as the hydrophobic layer and a transparent electrode. In this paper, the driving principle of the actuation, the flow resistance, the influence of the trapped charge and the difference between the oil-filled structure and air-filled structures are discussed.

### 6、新型开放式液滴驱动芯片

吴建刚, 岳瑞峰, 曾雪峰, 刘理天

电子器件, Vol. 28, No. 4, 2005

▣ 研制出一种利用介质上电润湿 (Electrowetting-on-dielectric, EWOD) 机理的新型开放式离散液滴驱动器, 它采用重掺杂多晶硅制备微电极阵列, 氧化硅以及碳氟聚合物薄膜作为复合疏水介质层, 悬挂的细硅铝丝作为参考零电极。通过控制施加在微电极阵列上的脉冲电压时序, 来精确操作和控制疏水介质层表面液滴的运动。该器件采用了悬挂线开放式结构, 在空气环境下, 在40 v低驱动脉冲电压下成功实现了液滴的传输。

### Novel Open-structure droplets Actuating chip

WU Jian-gang, YUE Rui-feng, ZENG Xue-feng, LIU Li-tian

Chinese Journal of Electron Devices, Vol. 28, No. 4, 2005

▣ A novel open-structure discrete droplets actuation based on Electrowetting-on-dielectric is presented, consisting of heavy doped poly-silicon used as the microelectrode array, the complex layer of the SiO<sub>2</sub> film and the fluorocarbon polymer film as the hydrophobic dielectric layer, the suspended silicon-aluminum line as the ground electrode. By controlling the sequence of voltage pulses applied to the microelectrode array under the dielectric layer, droplets on the surface of the hydrophobic layer could be manipulated. Owing to the suspended-line structure, the transportation of droplet was successfully achieved in air by applying the voltage pulse of 40V.

### 7、基于静电机制的MEMS液滴驱动器芯片

吴建刚 岳瑞峰 曾雪峰 刘理天

传感元件与传感器学术会议

▣ 本文提出了一种基于静电机制的可编程微电极阵列液滴驱动器, 它采用重掺杂多晶硅制备微电极阵列, 热氧化硅作为介质层, 碳氟聚合物薄膜作为疏水层。通过控制施加电压的脉冲时序, 操控电极阵列上疏水层表面的液滴。在空气环境下, 成功实现了液滴的快速传输, 液滴传输速度可达24mm/s, 驱动电压仅为30v。

### MEMS Droplets Actuating Chip Based on Electrostatic

WU Jian-gang, YUE Rui-feng, ZENG Xue-feng, LIU Li-tian

sensor element and sensor conference

▣ A prototype of a programmable electrostatic-based liquid droplet actuator is presented, consisting of heavy phosphorus-doped poly-silicon used as the microelectrode array, a SiO<sub>2</sub> film as the dielectric layer and a fluorocarbon polymer film as the hydrophobic layer. By controlling the sequence of voltage pulses applied to the microelectrode array under the dielectric layer, droplets on the surface of the hydrophobic layer could be manipulated. The rapid transportation of droplets was successfully achieved in air by applying the voltage pulse

of 30 V, and the transportation speed reached 24 mm/s.

## 8、硅基铁电微声学器件中薄膜残余应力的研究

杨轶, 张宁欣, 任天令, 刘理天

中国机械工程, 2005, 14: 1289-1291

采用基底曲率法测量了硅基铁电微声学器件中各层薄膜的残余应力情况, 通过调节热氧化的二氧化硅层的厚度, 优化了微声学器件中复合膜的残余应力, 得到平整的振膜结构, 提高了器件的可靠性和成品率。

## Residual Stresses in Thin Films of Silicon-Based Ferroelectric Micro-Acoustic Devices

Yang Yi, Zhang Ningxin, Ren Tian-Ling, Liu Litian

China Mechanical Engineering, 2005, 14: 1289-1291

The residual stresses in thin films of silicon-based ferroelectric micro-acoustic devices were measured by substrate curvature method. By adjusting the thickness of thermal silicon oxide layer, the residual stress of the multilayer membrane structure was minimized and a flat thin multilayer membrane had been achieved, which enhanced the reliability and yield of the micro-acoustic devices.

## 9、新型非制冷红外探测器

刘兴明, 韩琳, 刘理天

半导体光电 Vol.26, No.5, 2005

介绍了近年来出现的各种新型非制冷红外探测器, 对不同探测器的基本工作原理、器件结构、制作工艺以及性能的优缺点进行了讨论和对比, 并对非制冷红外探测器的改进方向进行了预测。

## New Types of Uncooled InfraRed Detectors

LIU Xing-ming, HAN Lin, LIU Li-tian

SEMICONDUCTOR PHOTOELECTRONICS, v26, n5, 2005

Various kinds of new uncooled infrared detectors recently developed are described in this paper. The basic mechanisms, device structures, technology and the performance difference are discussed and compared, and the optimize orientation also is predicted.

## 10、室温红外探测器研究与进展

刘兴明, 韩琳, 刘理天

电子器件 Vol.28, No.2, 2005

简要概述了室温红外探测器技术的最新研究现状, 首先根据工作机理的不同对红外探测器进行了分类, 详细阐述了室温红外探测器的优点所在; 接着在给出了室温红外探测器典型结构的基础上, 对这些典型结构进行了比较和讨论; 给出了最近出现的几种新型探测器, 介绍了其工作原理、制作工艺和主要性能指标; 最后对室温红外探测器的发展方向进行了预测。

## Research and Development of Uncooled Infrared Detectors

LIU Xing-ming, HAN-Lin, LIU Li-tian

Chinese Journal of ELECTRON DEVICES, v28, n2, 2005

The latest research status of uncooled infrared detectors is reviewed in this paper. Firstly, the infrared detectors are classified according to the different operation principle, and the merit of uncooled infrared detectors is particularly described. Secondly, the typical detector structures are presented, compared and discussed. This paper then describes the primary structures, technology and elementary indicators of several new detectors, and the development orientation of uncooled infrared detectors is predicted.

## 11、用于室温红外探测器的新型非晶硅薄膜晶体管

刘兴明 韩琳 刘理天

激光与红外 Vol.35, No.10, 2005

对用作室温红外探测器敏感元件的非晶硅薄膜晶体管进行了研究。分别从仿真和实验角度对非晶硅薄膜晶体管的沟道电流随着宽长比的线性变化进行了验证。对a-Si TFT沟道电流的温度特性进行了理论分析, 仿真和实验均表明, 增大晶体管的宽长比不会影响沟道电流温度系数, 但可以显著改善探测器的探测率, 为a-Si TFT红外探测器的优化设计指明了方向。

## Study on the Operational Mechanism of a-Si TFT Room Temperature InfraRed Detector

LIU Xing-Ming, HAN Lin, LIU Li-Tian

LASER & INFRARED, v35, n10, 2005

The a-Si thin film transistor(TFT) used as room temperature infrared(IR) detector is studied. The channel current of a-Si TFT changes linearly with the ratio of width to length (W/L), which is proved by simulation and experiment respectively. The temperature dependence of a-Si TFT current is theoretically analyzed. Based on the simulation and experiment, increasing W/L does not influence the temperature coefficient of current (TCC). However, larger W/L improved the detectivity evidently, which presents the orientation of a-Si TFT infrared detector design optimization.

**12、一种K波段双桥电容式RF MEMS开关的设计与制作研究**

雷啸锋 刘泽文 宣云 韦嘉 李志坚 刘理天

半导体学报, Vol.26, No.7, 2005

介绍了—种K波段双桥结构的电容式RF MEMS开关。该开关的结构特点是,在共面波导上的悬空金属膜为双桥结构,并且膜桥的支撑呈折叠弹簧结构。使用Agilent ADS软件对该开关进行了设计和优化,结果表明,相比传统电容式单桥开关,本文介绍的开关隔离度性能得到了很大提高。利用表面微机械工艺,在高阻硅衬底上制备了开关样品。双桥开关的在片测试结果表明:驱动电压为19.5V,“开”态的插入损耗约1.6dB@19.6GHz,“关”态的隔离度约46.0dB@19.6GHz。

**Design and Fabrication of K-band Double Bridge Capacitive MEMS Switches**

Lei Xiaofeng, Liu Zewen, Xuan Yun, Wei Jia, Li Zhijian, Liu Litian

Chinese Journal of Semiconductors, Vol.26, No.7, 2005

Design and fabrication of a novel K-band capacitive RF MEMS switch is reported. The switch consists of two suspended metallic membrane supported by the serpentine flexible spring over the coplanar waveguide. The design is optimized based on a series of simulations, which is realized with commercial EDA tools. The simulations show that the proposed switch structure present improved isolation in relative low RF frequency (K band). This switch is made using silicon surface micromachining process. On wafer measurement results have been carried out. The threshold voltage is less than 19.5V, the insertion loss is 1.6dB@19.6GHz, and the isolation is 46.0dB@19.6GHz.

**13、介质表面形貌对射频微机械开关隔离度影响**

雷啸锋 刘泽文 宣云 韦嘉 李志坚 刘理天

清华学报, 已录用

针对粗糙介质表面造成射频微机械(RF MEMS)开关隔离度衰减的问题,设计了一个双桥电容式RF MEMS开关,分别采用金属Au和Al作为开关的下电极,以SiN作为电容介质制备了样品。微波特性测量表明两种材料开关的隔离度有很大区别。利用原子力显微镜对金属Au和Al上制作的SiN介质层表面进行了测试,表面粗糙度Ra值分别为13.050nm和66.680nm,分析得到相应的关态电容减少因子分别为0.52和0.15。为获得较好的开关隔离度,介质表面粗糙度须控制在5nm以下。

**Effect of surface roughness of dielectric layer on the isolation of RF MEMS switch**

Lei Xiaofeng, Liu Zewen, Xuan Yun, Wei Jia, Li Zhijian, Liu Litian

Journal of Tsinghua University, accepted

A study on the surface roughness of dielectric layer on different electrodes and its effect to the isolation of radio-frequency microelectromechanical (RF MEMS) switches is presented in this paper. The study is based on a double-bridge capacitive RF MEMS switch. In this switch SiN is used as the dielectric layer and the lower electrode is fabricated with gold and aluminum respectively. The RF network measurement shows that isolation performance of two switches is very different. The surface roughness of SiN dielectric layer on different metallic electrode is measured with atomic force microscopy and the roughness Ra is 13.050nm for SiN/Au and 66.680nm for SiN/Al respectively. The corresponding degradation factors of off-state capacitance for the two electrodes are 0.52 and 0.15. The roughness less than 5nm is needed in order to get better isolation of switch.

**14、一种X波段RF MEMS开关的设计与制作研究**

雷啸锋 刘泽文 宣云 韦嘉 李志坚 刘理天

电子器件, 已录用

设计并制作了一种X波段的电容式RF MEMS开关。该开关在共面波导上的悬空金属膜桥的支撑梁呈螺旋结构,其等效电感值高达134pH,有效降低了“关”态的谐振频率。结合开关的等效电路模型,使用Agilent ADS软件以及理论公式计算对该开关进行了设计和优化。相比传统桥膜电容式开关,本文介绍的开关“关”态隔离性能得到了很大提高。利用表面微机械工艺,在高阻硅衬底上制备了开关样品。X波段MEMS开关的在片测试结果表明:驱动电压为9V,“开”态的插入损耗约0.69dB@11.6GHz,“关”态的隔离度约27.7dB@11.6GHz。

**Design and Fabrication of X-band Capacitive MEMS Switches**

Lei Xiaofeng, Liu Zewen, Xuan Yun, Wei Jia, Li Zhijian, Liu Litian

Journal of Electron Devices, accepted

Design and fabrication of a novel X-band capacitive RF MEMS switch is reported. The switch consists of a suspended metallic membrane supported by the like-coil structure over the coplanar waveguide. The equivalent inductance of the like-coil structure is 134pH, which greatly decrease the off-state resonate frequency of the switch. The design is optimized based on a series of simulations, which is realized with commercial EDA tools. The simulations show that the proposed switch structure present better isolation than traditional switch in relative low RF frequency (X band). This switch is made using silicon surface micromachining process. On wafer measurement results have been carried out. The threshold voltage is less than 9V, the insertion loss is 0.69dB@11.6GHz, and the isolation is 27.7dB@11.6GHz.

**15、一种新型的三谐振点电容式RF MEMS开关研究**

雷啸锋 刘泽文 李志坚 刘理天

固体电子学研究与进展, 已录用

给出了改进的电容式开关等效电路模型以及基于该电路模型的一种新型的多频段工作的电容式RF MEMS开关的设计和制作

研究。分析表明,当开关的上电极为多支撑梁结构时,需要对传统的开关等效电路加以改进。利用新型等效电路模型进行模拟发现,通过适当的参数选择,可以获得多谐振点开关,不仅可以在多个频段适用,并且可以适用于较低频段。设计了一种可在X波段和毫米波段下的3谐振点电容式RF MEMS开关,并在高阻硅衬底上采用表面微加工工艺制备了开关样品。3谐振点开关的在片测试结果为:驱动电压为7V,“开”态的插入损耗为0.69dB@10.4GHz,“关”态的隔离度为30.8dB@10.4GHz,其微波性能在0-13.5GHz频段下优于类似结构的传统单谐振点开关。

### Study on a novel 3-resonance capacitive RF MEMS switch

Lei Xiaofeng, Liu Zewen, Li Zhijian, Liu Litian

Research and Progress of Solid State Electronics, accepted

■ A modified equivalent circuit for capacitive RF MEMS and a novel switch design based on the modified equivalent circuit is presented. Analysis shows that the traditional RLC series circuit model is incomplete when capacitive switch has multiple support beams. Simulation results show that the multi-resonance switch can work in multiple frequency bands and has very good isolation in low frequency. A 3-resonance switch is designed and fabricated on high-resistivity silicon substrate. The actuation voltage of the fabricated 3-resonance point switch is 7V, and the insertion loss is 0.69dB@10.4GHz, the isolation is 30.8dB@10.4GHz. The performance is far better than traditional single-resonance switch at frequency lower than 13.5GHz.

### 16、一种4kb铁电存储器的设计

安黎 魏朝刚 任天令

微电子学, Vol.35, No.4:437-440, 2005

■ 以清华大学微电子所的铁电存储器工艺为基础,设计了一个规模为4kb(512×8位)的铁电存储器,包括存储阵列、灵敏放大器、字线位线译码、驱动脉冲产生等模块。设计中,采用新开发的铁电电容模型,文中重点介绍了与传统DRAM、SRAM等存储单元完全不同的铁电存储单元的设计方法。仿真结果表明,铁电存储器在5V工作电压下工作周期为120ns。

### Design of a 4 k Bit Ferroelectric Memory

An Li, Wei Chao-Gang, Ren Tian-Ling

Microelectronics, Vol.35, No.4:437-440, 2005

■ A 4 k bit(512×8 bit)FeRAM array is designed with 1 btm design rules developed by Institute of Microelectronics of Tsinghua University. The design method for ferroelectric memory, which is quite different from that of conventional memories. such as SRAM and DRAM, is described in particular in the paper. Simulation results show that the device operates at 5 V power supply with a working cycle of 120 ns.

### 17、磁控溅射法制备IrMn底钉扎自旋阀研究

欧阳可青 任天令 刘华瑞 曲炳郡 刘理天 李伟

功能材料与器件学报, Vol.11, No.2:143-148, 2005

■ 采用高真空直流磁控溅射的方法,在玻璃衬底上制备了结构为Ta / buffer layer / IrMn / CoFe / Cu / CoFe / NiFe / Ta的IrMn底钉扎自旋阀。研究了NiFe和Cu作为缓冲层对自旋阀磁性能的影响,并对缓冲层厚度进行了参数优化,当缓冲层厚度为2nm时自旋阀各项性能达到最佳。研究了退火制度对底钉扎自旋阀性能的影响,得到了30000e强磁场下200℃保温1h为最佳处理条件。通过结构的改善和工艺的优化,得到的底钉扎自旋阀的磁电阻率8.51%,矫顽场为0.50e,交换偏置场超过8000e。最后对自旋阀的底钉扎和顶钉扎结构进行了比较。

### Investigation on high vacuum magnetron sputtered IrMn bottom spin valves

Ouyang Ke-Qing, Ren Tian-Ling, Liu Hua-Rui, Qu Bing-Jun, Liu Li-Tian, Li Wei

JOURNAL OF FUNCTIONAL MATERIALS AND DEVICES, Vol.11, No.2:143-148, 2005

■ The IrMn bottom spin valves. with structure of Ta / buffer layer / IrMn / CoFe / Cu / CoFe / NiFe / Ta, were deposited on glass substrate by high vacuum DC magnetron sputtering method. The effect of NiFe and Cu buffer layer was investigated, and an optimized thickness(2nm)of buffer layer is proposed for the bottom pinned structure. The thermal annealing effect on the GMR properties in bottom pinned structure was discussed. The spin valves get high MR ratio(>8.5%), low coercivity (<0.80e), and high exchange bias field(>8000e)after the optimizing the structure parameters and annealing conditions. Spin valve with bottom structure is compared with which with top structure.

### 18、硅基AlN薄膜制备技术与测试分析

于毅 任天令 刘理天

半导体学报, Vol.26, No.1:42-45, 2005

■ 采用直流磁控反应溅射法,在Si(100), Al / Si(100)和Pt / Ti / Si(100)等多种衬底上制备了用于MEMS器件的AlN薄膜。用XRD和AES对薄膜的结构和组分进行了分析,通过优化工艺参数,得到了提高薄膜择优取向的方法,并分析了不同衬底上AlN晶粒生长的有关机理。制备的AlN薄膜显示出良好的<002>择优取向性,摇摆曲线的半高宽达到5.6°。

### Deposition and Characterization of AlN Thin Films on Silicon

Yu Yi, Ren Tian-Ling, Liu Li-Tian

CHINESE JOURNAL OF SEMICONDUCTORS, Vol.26, No.1:42-45, 2005

Aluminum nitride(AIN)thin films for MEMS devices have been successfully deposited on Si(100), Al / Si(100)and Pt / Ti / Si(100)by DC magnetron reactive sputtering. X-ray diffraction(XRD)and Auger electron spectroscopy(AES)are used to analyze crystalline orientation and components of the films. The influence of different processing parameters on the film preferential orientation is investigated. The growth mechanism of AIN crystallites on different substrates is also discussed. These films show a excellent preferred orientation of(002)with a rocking curve FW HM of 5.6° .

## 19、基于模糊推理的压力传感器温度补偿方法研究

单伟伟 靳东明

2005年中国模糊逻辑与计算智能联合学术会议 (FLCI2005)

2005年4月16-18日 广东 深圳 论文集(上册):39-43.

温度是影响压力传感器的一个重要因素,为了补偿温度造成的误差,探讨了一种新方法,即用模糊逻辑推理的方法建立温度补偿模型进行压力传感器温度的非线性误差校正。校正后的最大误差仅在0.5%以内。由于使用了零阶Takagi-Sugeno模型,简化了模糊推理的计算,具有运算简单和速度快的特点,适合硬件实现,有利于和传感器集成在一个芯片上,实现具有温度补偿功能的智能传感器。

### A Study of Fuzzy Reasoning Based Temperature Compensation in Pressure Sensors

Shan Wei-wei, Jin Dong-ming

The 2005 National Joint Conference on Fuzzy Logic and Computational Intelligence (FLCI2005)

April 16-18,2005, Shenzhen, Guangdong, China, Proceedings(Volume 1) :39-43.

Temperature is an important factor that influences the accuracy of a pressure sensor. A new compensation method — fuzzy reasoning based error collection was presented in this paper. Compared to other compensation techniques, it is a new, simplified compensation method that not only gives an error of 0.5% but also calculates very fast, because fuzzy logic only deals with some simple operations such as max, min, sum, and multiplication. This method can be integrated in one chip with the sensor, thus forms a smart sensor with temperature compensation.

## 20、神经网络权值存储电路研究与进展

王鹏, 张洵, 靳东明

2005年中国模糊逻辑与计算智能联合学术会议 (FLCI2005)

2005年4月16-18日 广东 深圳 论文集(上册):217-222.

人工神经网络是信息处理领域的重要方法,有十分广泛的应用前景。采用集成电路技术实现神经网络能充分发挥神经网络并行处理的特点。神经网络的权值存储是集成电路实现技术中亟待解决的重要问题。文中综述了神经网络权值存储的主要研究成果。

### Research and Development of Neural Networks Weight Storage Circuit

Wang Peng, Jin Dong-ming

The 2005 National Joint Conference on Fuzzy Logic and Computational Intelligence (FLCI2005)

April 16-18,2005, Shenzhen, Guangdong, China, Proceedings :217-222.

Artificial neural networks are an important method of information processing field, and have a wide application range. The characteristics of neural networks can be sufficiently embodied by VLSI implementation. The storage of neural network weight is an important problem of VLSI implementation to be solved. This paper summarized the research of neural networks weight storage.

## 21、多分辨率组合模糊最小最大分类器的硬件设计

范思强, 靳东明

2005年中国模糊逻辑与计算智能联合学术会议 (FLCI2005)

2005年4月16-18日 广东 深圳 论文集(下册):542-546

针对多分辨率组合模糊最小最大分类器模型(MRC-FMMC)提出一种软件学习硬件分类的实现方案,并用并行结构实现硬件部分。该设计采用并行推理模块对输入数据进行并行分类,推理模块之间相互独立,且推理模块数目可以根据需要进行选择,所有推理模块由控制模块进行控制,且推理模块与控制模块之间采用异步接口,两者可以工作在不同频率。该分类器用Xilinx的spartanII器件实现可以稳定工作在50M Hz。用SMIC0.18um工艺进行ASIC设计后仿真可以工作在100MHz。实际测量的分类结果与模拟结果完全一致。并可以方便实现片间的级连。

### The Hardware Design of a Multi-Resolution Combined Fuzzy Min-Max Classifier

FAN Si-qiang, JIN Dong-ming<sup>1</sup>

The 2005 National Joint Conference on Fuzzy Logic and Computational Intelligence (FLCI2005)

April 16-18,2005, Shenzhen, Guangdong, China, Proceedings(Volume 2) :542-546.

This paper put forward a scheme of designing a Multi-Resolution Combined Fuzzy Min-Max classifier by software studying and hardware classification and the hardware is implemented with parallel structures. Using parallel classification logic modules controlled by a

control logic module to classify different patterns simultaneously we can get several results at one time. The classification logic modules are unattached and the numbers of them are optional. The I/O between the control logic modules and the classification logic modules is asynchronous, which makes them work under different frequency. The processor has been implemented by FPGA from Xilinx Spartan II series and it can work under the frequency of 50MHz. It has also been designed by ASIC and the area is 1.83mm×1.83mm in a 0.18um CMOS process from SMIC. It can work in the frequency of 100MHz. the testing result is coincident with the simulation one and it is convenient to connect the chips to make them work together.

## 22、基于模拟电路实现的模糊控制单元电路设计

王为之, 靳东明

2005年中国模糊逻辑与计算智能联合学术会议 (FLCI2005)

2005年4月16-18日 广东 深圳 论文集(下册):983-987.

■ 本文提出了一系列基于标准CMOS工艺的电压型模拟电路单元, 这些电路可以应用于模糊控制等相关领域; 包括: 类Gauss型隶属度函数电路, 多输入电压求小电路和不需要除法器构成的电压控制的加权平均电路。这些电路结构简单, 满足系统精度要求, 并便于扩展和调节, 可以直接增加相应的电路单元以实现复杂系统的模糊控制。

### Analog Circuit Block of Fuzzy Control

WANG Wei-zhi, JIN Dong-ming

The 2005 National Joint Conference on Fuzzy Logic and Computational Intelligence (FLCI2005)

April 16-18,2005, Shenzhen, Guangdong, China, Proceedings(Volume 2) :983-987.

■ This paper intends outlining several analog integrated circuits designed in standard CMOS technologies, which could be used in fuzzy inference system as the general modules. Voltage-mode CMOS implementation of minimum circuit, programmable Gaussian-like membership function circuit, and normalization circuit based on centroid algorithm without division are proposed. The simplicity as well as the programmability of these circuits permits increasing controller complexity, by adding rules and/or input, with no extra design effort.

## 23、自适应模糊控制器的VLSI实现研究

徐志浩, 靳东明, 李志坚

2005年中国模糊逻辑与计算智能联合学术会议 (FLCI2005)

2005年4月16-18日 广东 深圳 论文集(下册):988-994.

■ 以梯度下降学习算法为基础, 设计了一个自适应模糊控制器电路。该自适应模糊控制器由一个单输入单输出的模糊控制器和与之配合使用的自适应学习电路单元组成, 在输入的监督信号的指导下可以按梯度下降学习算法的原理自动的调节自身的规则参数, 从而实现了硬件电路的在线片上学习的功能。最后以有限论域上的函数逼近问题为例进行了验证, Hspice仿真结果表明, 该电路可以完成自适应学习功能。

### Investigation Of Adaptive Fuzzy Logic Controller VLSI Implementation

Xu Zhihao, Jin Dongming, Li Zhijian

The 2005 National Joint Conference on Fuzzy Logic and Computational Intelligence (FLCI2005)

April 16-18,2005, Shenzhen, Guangdong, China, Proceedings(Volume 2) :988-994.

■ A circuit of a single input single output Adaptive fuzzy logic controller is presented. The key cell based on gradient-descent algorithm is designed for on chip learning of the fuzzy logic controller. Combining the designed fuzzy logic controller and the learning circuit cell, an adaptive fuzzy logic controller is completed, which can tune the rule base parameters automatically with the help of a direction signal. Hspice simulation of function approximation experiment was made, showing that the circuit can realize the designed capability.

## 24、适于硬件实现的论域自适应模糊控制器设计

张洵, 王鹏, 靳东明

2005年中国模糊逻辑与计算智能联合学术会议 (FLCI2005)

2005年4月16-18日 广东 深圳 论文集(下册):995-999.

■ 本文通过改进型论域自适应模糊控制器, 实现对非线性系统的模糊控制。与传统的模糊控制器相比, 大幅度节省了硬件开销, 且加速了系统的收敛过程。通过对倒立摆系统在线模拟, 证实了该控制算法的有效性和适用性, 并讨论了这种控制算法的理论基础及最优控制策略。以此为依据, 对一级倒立摆进行了实时控制, 摆可稳定于任意指定位置, 所得轨迹与理论值近似, 证实了硬件芯片设计制造的可行性, 以及提供了有价值的理论基础。

### A New Type of Self-Adaptive Domain Mapping Fuzzy Controller

Zhang Xun, Wang Peng, Jin Dong-ming

The 2005 National Joint Conference on Fuzzy Logic and Computational Intelligence (FLCI2005)

April 16-18,2005, Shenzhen, Guangdong, China, Proceedings(Volume 2) :995-999.

■ In this paper, a new improved domain adaptive fuzzy controller is described, which can control the system with nonlinear, time-varying, uncertain transfer function well. Compared with traditional fuzzy controller, it saves the hardware consumption, and accelerates the

system convergence. The nonlinear control system of inverted pendulum is simulated on-line with this design, which proves the validity and the applicability of this proposed control method. The theory and optimization of the method are also discussed. According to this strategy, first order inverted pendulum real-time control system is realized. It is found that the results of the theory and the experimentation are consistent with each other, and the pendulum can stabilize at any position as well. Because the configuration is simple, this approach provides a valuable theory basement to the implement of hardware chip in the future.

## 25、PDMS 封装技术在硅基微型直接甲醇燃料电池中的应用

姜英琪, 王晓红, 邱新平, 钟凌燕, 白玉霞, 刘理天

中国机械工程, Vol 16, No 14, 2005

在分析了PDMS 应用优势的基础上,介绍了一种基于PDMS 的封装技术,将此技术应用于硅基直接甲醇燃料电池的制作中,并对电池性能进行了测试。实验表明,PDMS 封装技术能够有效解决封装的密封性、燃料输运导管固定、电池组件间的接触性等问题,并具有长期可靠性。应用PDMS 封装技术的微型直接甲醇燃料电池性能优良,可以驱动一些低功率电子器件和MEMS 器件。

## Applications of PDMS assembly technology to silicon-based micro direct methanol fuel cell

Jiang Yingqi, Wang Xiaohong, Qiu Xinping, Zhong Lingyan, Bai Yuxia, Liu Litian

China Mechanical Engineering, v 16, n 14,2005

Based on analyses of the advantages of PDMS material properties, this paper presented a set of novel and detailed PDMS assembly processes, which was used in the fabrication and test of a silicon-based micro direct methanol fuel cell ( $\mu$ DMFC). The results demonstrate that the PDMS assembly technology is able to solve the issues such as effectiveness of the cell package, the fixation of the feeding holes, the contact between layers and, at the same time, has long-term durability. The  $\mu$ DMFC prototype assembled by PDMS has achieved good performance and can be applied in low-power applications and MEMS devices.

## 26、基于CFD的DMFC阳极三维模型的建立

钟凌燕, 王晓红, 谢克文, 姜英琪

中国机械工程, Vol.16,2005, pp.214-217

提出基于计算流体力学方法的直接甲醇燃料电池阳极的三维模型,并模拟了液体燃料供给的平行沟道流场结构直接甲醇燃料电池的性能。该模型考虑直接甲醇燃料电池阳极燃料的质量传输,特别是多孔介质对于燃料输运的影响,根据燃料质量传输性质,求出直接甲醇燃料电池的输出电压、平均电流密度等电性能。对不同输入燃料浓度的直接甲醇燃料电池性能进行模拟得到的模拟结果与实验规律一致,输入燃料浓度的增加将使直接甲醇燃料电池的极限输出电流密度成比例增加。

## The Numerical Simulations in a Three-dimensional Model of Direct Methanol Fuel Cell Anode- using Computational Fluid Dynamics Method

Zhong Lingyan, Wang Xiaohong, Xie Kewen, Jiang Yingqi

China Mechanical Engineering, v16, 2005, pp.214-217

A three-dimensional model based on Computational Fluid Dynamics (CFD) is presented to describe the electrical performance of direct methanol fuel cell (DMFC), and the anode with parallel flow channels of a liquid feed DMFC is simulated. The mass transportation of fuel in DMFC anode is considered, especially in porous medium. Accordingly, the three-dimension distribution of fuel concentration and current density in the anode of DMFC is calculated, and the cell voltage and average current density can be predicted. The simulated results correspond with experimental results, and it can be observed that the increase in fuel concentration leads to the increase in DMFC output current density proportionally.

## 27、用于射频领域的MEMS无源LC滤波器设计研究

方杰刘泽文 陈忠民 刘理天 李志坚

清华大学微电子学研究所, 北京, 100084

本文介绍了一种利用MEMS工艺实现的用于射频领域的无源LC低通滤波器的设计、仿真和制作。该低通滤波器(LPF)采用三阶Chebyshev最少电容原型结构,设计-3dB带宽为3GHz,插入损耗小于2dB。基于MEMS无源元件(电容和电感)的集总物理模型,实现了对LPF实际性能的等效电路仿真,同时进行了版图和结构的验证。利用MEMS工艺实现的低通滤波器其-3dB带宽和通带内插入损耗分别为2.925GHz和1.2dB(在1GHz下),制作工艺与标准CMOS工艺兼容。

## Design of a RF MEMS Passive LC Filter

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Institute of Microelectronics, Tsinghua Univ., Beijing, 100084

The design, simulation and fabrication of a RF MEMS LC low-pass filter are presented. The design of the LPF is based on a basic minimum capacitor prototype structure, with -3dB bandwidth of 3GHz and midband insertion loss of less than 2dB. According to the physical model of on-chip MEMS inductors and MIM capacitors, the equivalent circuit of LPF is simulated and verified with layout and structure simulation. The LPF is accomplished with MEMS process, which is compatible with standard CMOS IC technology. Measurement results give -3dB bandwidth of 2.925GHz and midband insertion loss of 1.2dB at 1GHz.

## 28、硅基微型直接甲醇燃料电池的研究

王晓红, 谢克文, 姜英琪, 钟凌燕, 刘理天



半导体学报, Vol 26, No 7

设计了一种基于MEMS技术的硅基微型直接甲醇燃料电池(DMFC),采用流体力学软件进行了DMFC三维阳极模型的模拟,利用MEMS加工技术和PDMS封装工艺实现了这种燃料电池,并在室温下对有效面积为 $8600\mu\text{m} \times 8600\mu\text{m}$ 的电池样品进行了性能测试.测试得到该DMFC的开路输出电压为0.15V,短路工作电流密度达到 $7811\text{mA}/\text{cm}^2$ ,最大输出功率密度为 $3186\text{mW}/\text{cm}^2$ .主要参数已达到了一些电子器件的要求,具有一定的实用价值.

### Silicon-based micro direct methanol fuel cell

Wang Xiaohong, Xie Kewen, Jiang Yingqi, Zhong Lingyan, Liu Litian

Chinese Journal of Semiconductors, Vol 26, No 7, 2005

A silicon-based micro direct methanol fuel cell (DMFC) with an  $8600\mu\text{m} \times 8600\mu\text{m}$  active area is designed. The simulation of a 3D anode model for the liquid-feed micro DMFC based on fluid dynamic technologies is presented. Two bipolar plates with flow fields are fabricated on silicon wafers using MEMS technology. The cell is assembled by sandwiching the MEA between two bipolar plates using PDMS. The testing results show that the open circuit voltage is 0.5 V and the maximum output power density is  $3.86\text{mW}/\text{cm}^2$  when 1 M methanol is fed at room temperature. This power density can satisfy the requirements of power consumption of many electronic devices.

## 29、金锡焊料及其在电子器件封装领域中的应用

周涛、Tom Bobal、Martin Oud、贾松良

电子与封装, Vol.5, No.8, 2005

本文介绍了Au80%Sn20%焊料的基本物理性能。同时介绍了这种焊料在微电子、光电子封装中的应用。

### An Introduction to Eutectic Au/Sn Solder Alloy and Its Performs in Microelectronics/Optoelectronic Packaging Applications

Zhou Tao, Tom Bobal, Martin Oud, Jia Song-liang

Electronics and packaging, v5, n8, 2005

The physical properties of eutectic Au/Sn solder alloy and its application for microelectronics and optoelectronics packagings.

## 30、金属封装用低阻复合引线的优化设计

杨宇, 贾松良, 张忠会, 蔡坚, 王水弟

半导体技术, Vol.30, No.8, 2005

给出了以容易测量的内芯材料横截面积所占整个复合引线面积之比为自变量的同轴复合圆柱形引线的电阻率、轴向和径向的热膨胀系数的计算公式。运用这些公式并从相应图中可以便捷地确定这类复合材料的优化设计范围。将该结果应用于4J50包铜复合引线的优化设计,并进行了实验验证。

### Optimized Design of Compound Wire with Low Electrical Resistivity for Metal Packaging

YANG Yu, JIA Song-liang, ZHANG Zhong-hui, CAI Jian, WANG Shui-di

Semiconductor Technology, v30, n8, 2005

The column-shaped wire with a core material clad with an outer sleeve is extruded along one axis. The area ratio of the core material to the whole wire can be measured easily from the cross section. The conductivity, coefficients of thermal expansion (CTE) parallel to and normal to extrusion axis could be calculated. The optimize design range of this kind materials can be determined according to the formulas and the graph. It was used and validated in the 4J50 design.

## 31、硅基CoZrO铁氧体磁膜结构RF集成微电感

杨晨 刘锋 任天令 刘理天 冯海刚 王自惠 龙海波 于军

半导体学报, Vol.26, No.11, 2005

制作了一种新型磁膜结构射频集成微电感。该电感使用溶胶-凝胶法制备的CoZrO铁氧体作为磁性薄膜;采用平面单匝形式金属线圈,从而形成“ $\text{SiO}_2$ 绝缘层/磁膜层(CoZrO)/ $\text{SiO}_2$ 绝缘层/Cu线圈”的结构,具有结构简单、制作工艺与常规集成工艺兼容等特点。同时,采用相同工艺同批制作了无磁膜微电感作为对比样品,并取各项结构参数与磁膜电感相一致。测试结果表明,2GHz处,磁膜结构微电感的感值(L)为 $1.75\text{nH}$ 、品质因数(Q)为18.5,与无磁膜微电感相比,L和Q的值分别提高了25%和23%。

### An RF integrated inductor with CoZrO ferrite thin film

Yang Chen, Liu Feng, Ren Tian-Ling, Liu Litian, Feng Haigang, Wang Zihui, Long Haibo, Yu Jun

Chinese Journal of Semiconductors, v26, n11, 2005

A novel RF integrated inductor with ferrite thin-film is fabricated. The inductor has a simple structure of “ $\text{SiO}_2$  insulating layer / magnetic thin-film (CoZrO) /  $\text{SiO}_2$  insulating layer / Cu coils”, in which planar single-turn metal coil and CoZrO ferrite thin-film fabricated by Sol-Gel method are used. The fabrication processes is compatible with standard integrated processes. Inductors without magnetic thin-film are fabricated as the referential sample using the same processes, in which the structure parameters are consistent with the

inductor with magnetic thin-film. The inductance (L) of the inductor with magnetic thin-film is 1.75nH and the quality factor (Q) is 18.5 at 2GHz. Compared with the inductor without magnetic thin-film, L and Q are raised by 25% and 23%, respectively.

### 32、新型层叠结构磁膜微电感的集成工艺研究

杨晨 刘理天 刘锋 任天令

第九届全国敏感元件与传感器学术会议 (STC'05)

本文制作了一种采用“Pt底电极/铁氧体磁性薄膜/Cu线圈”结构形式的新型磁膜微电感。该电感使用铁氧体磁膜作为中间层磁性增强元件,形成层叠通孔结构。电感制作过程的关键步骤包括:使用溶胶-凝胶(Sol-Gel)法、旋涂法和快速热处理(RTP)工艺制作铁氧体磁性薄膜;采用离子束刻蚀(IBE)工艺进行磁膜刻蚀,制作磁膜通孔;利用溅射和电镀方法制作底电极和电感线圈。实验表明,该新型层叠结构磁膜微电感制作工艺流程简单可靠,与常规集成工艺相兼容。

#### Fabrication research on novel stacked magnetic thin-film micro-inductor

Yang Chen, Liu Litian, Liu Feng, Ren Tian-Ling

STC'05

A novel magnetic thin-film micro-inductor with stacked “Pt underpass / magnetic thin-film/ Cu coils” structure is fabricated. Ferrite thin-film is adopted for the middle magnetic layer, which is used as the magnetic amplifying component. The key processes in the whole fabrication include: the deposition of ferrite thin-film using sol-gel method, spin-coated technique and rapid thermal annealing process (RTP); the etch of ferrite thin-film using ion beam etching (IBE) to form the vias; the fabrication of underpass and spiral coil using sputtering and electroplating methods. The whole fabrication is stable and simple, which is compatible with IC process.

### 33、高阻硅上RF-MEMS共面波导设计及测量研究

刘泽文 宣云 雷啸锋 李志坚 刘理天

光学精密工程, 2005年4月, 第13卷, 第2期, 158-164

本文对高阻硅上RF-MEMS共面波导传输线(CWP)进行了设计,并测量和分析了不同偏压下的特征阻抗值。利用部分电容法和保角变换法得到的分析公式确定了特征阻抗为 $50\Omega$ 的共面波导的几何结构尺寸,采用MEMS准平面加工工艺在高阻硅衬底上实现了 $2.5\mu\text{m}$ 厚的金共面波导结构。在施加不同直流偏压的情况下对所设计的共面波导其进行了S参数测量。计算了Winkel多项式中所有系数的具体表达式,运用该多项式获得了共面波导的特征阻抗,并与传统的特征阻抗提取方法进行了结果比较。实验数据表明,在中心信号线上施加的直流偏压对S参数的影响很小,而对共面波导特征阻抗的影响较为明显,当施加的直流偏压从0V变为38V时,特征阻抗的实部会增加,变化幅度小于 $1.2\Omega$ ,虚部会减小,变化幅度小于 $0.8\Omega$ 。

#### Study on Design and Measurement of RF-MEMS CPW on HRS

LIU Zewen XUAN Yun LEI Xiaofeng LI Zhijian LIU Litian

OPTICS AND PRECISION ENGINEERING, Vol.13, n2, 2005, 158-164

Transmission line is an essential element in RF-MEMS circuit. In this paper, a study on design of RF-MEMS coplanar-waveguide (CPW) on high resistivity silicon (HRS) and measurement of this CPW under different bias-voltage are presented. The dimension of the CPW is designed with partial-capacitance method and conformal mapping method. The designed CPW transmission line is realized on 3 inches HRS wafer with a resistivity of  $1000\Omega\cdot\text{cm}$ . The substrate and metal layer is insulated by  $0.8\mu\text{m}$  silicon dioxide layer formed by oxygenation.  $2.5\mu\text{m}$  thick electroplated gold is selected as the material of metal layer. The width of the central signal line is  $196\mu\text{m}$  and the gap between signal line and ground line is  $120\mu\text{m}$ . The S-parameters measurement of the designed CPW is performed with 0V and 38V bias on the central signal line by HP 8722ES network analyzer. The characteristic impedance of designed CPW is extracted using Winkel's method, the necessary specific polynomial is given in this paper. The extracted parameters show that the influence of bias-voltage on characteristic impedance is observable. When the bias-voltage on central signal line is changed from 0V to 38V, the change of the real part of the characteristic impedance is about  $1.2\Omega$ ; the change of the image part of the characteristic impedance is about  $0.8\Omega$ .

### 34、一种新型的CMOS温度传感器

张洵 王鹏 靳东明

半导体学报, 2005, 26(11)

提出了一种采用标准CMOS工艺制造的全CMOS电路结构温度传感器的理论及其电路设计。采用CSMC  $0.6\mu\text{m}$ 的数模混合工艺仿真表明,在 $-40^\circ\text{C}$ 到 $125^\circ\text{C}$ 的温度范围内,温度灵敏度为 $-1.15\mu\text{A}/^\circ\text{C}$ 。芯片实测,温度灵敏度为 $-0.99\mu\text{A}/^\circ\text{C}$ 。5V供电时,静态功耗 $1.5\text{mW}$ 。芯片面积 $0.025\text{mm}^2$ 。该传感器的特性表明它非常适用于高容量的集成微系统中,在汽车电子、石油采集、生物医学等领域有着广阔的应用前景。

#### A New Type CMOS Temperature Sensor

Zhang Xun, Wang Peng, Jin Dongming

Chinese Journal of Semiconductors, 2005, 26(11)

The theory and design of compatible wide range smart temperature sensors in standard CMOS technology is presented in this paper. The temperature sensitivity simulated using CSMC  $0.6\mu\text{m}$  mixed-signal CMOS process is  $1.15\mu\text{A}/^\circ\text{C}$  (over the temperature range  $-40^\circ\text{C}$  to  $125^\circ\text{C}$ .) and measured is  $0.99\mu\text{A}/^\circ\text{C}$ . The power dissipation of the sensor is  $1.5\text{mW}$  at a 5V voltage supply, chip area is  $0.025\text{mm}^2$ . The characteristics of this sensor make it especially suitable for low-cost high-volume integrated microsystems over a wide range of fields, such

as automotive, oil prospecting, biomedical, and consumer.

### 35、硅基垂直腔面光发射器件的研制

姚永昭, 岳瑞峰, 刘理天

清华大学学报, 2005, 45(4): 553-556.

本文提出了一种新型硅基垂直腔面光发射器件结构。它采用等离子增强化学汽相淀积方法制备的非晶硅(或非晶氮化硅)/二氧化硅交替生长的多层薄膜结构为分布式布拉格反射器(DBR), 以夹在上下两个布拉格反射器之间的非晶碳化硅薄膜为中间发光层。通过设计与模拟, 分析了DBR中薄膜生长顺序与层数对器件性能的影响。最后研制出光致红光发射器件和电致蓝绿光发射器件, 并给出了它们的光致和电致发光谱。结果显示了在光致和电致激发下非晶碳化硅的发光和DBR对光谱的限制增强作用。

#### Design and fabrication of Si-based vertical cavity surface light emitter

YAO Yongzhao, YUE Ruifeng, LIU Litian

J. TSINGHUA UNIVERSITY SCIENCE AND TECHNOLOGY, 2005, 45(4): 553-556.

A Si-based novel vertical cavity surface light emitter (VCSLE) was proposed. Its distributed Bragg reflectors were composed of periodically stacked PECVD a-SiO<sub>2</sub>:H/a-Si:H layers and the active layer was filled with a-SiC<sub>x</sub>:H. The number and order of periodically stacked multilayers were determined through simulating. The photoluminescent (PL) red light emitter and electroluminescent (EL) blue-green light emitter were fabricated. The PL and EL spectra were recorded, which showed a-SiC<sub>x</sub>:H luminescence and DBR effect on the spectra.

### 36、汽车轮胎压力监控传感器研究

张兆华、岳瑞峰、谭智敏、刘理天

中国机械工程, Vol.16, 增刊, 2005

轮胎压力监视系统 TPMS(Tire Pressure Monitoring System)是一种重要的汽车安全用电子信息系统, 它能够在汽车行驶过程中对轮胎气压以及温度进行自动监测, 在轮胎漏气或者轮胎气压值过低以及过高时进行报警, 提示驾驶人员及早采取必要的措施, 以保障行车安全。本文分析了轮胎压力监控系统的原理及各种不同的解决方案, 研究并分析了一种新型的轮胎压力监控传感器。

#### Study of Tire Pressure Monitoring Sensor

Zhao hua Zhang, Rui feng Yue, Zhi min Tan, Li tian Liu

Chinese Mechanical Engineering, v16, 2005

Tire Pressure Monitoring System (TPMS) is very important for the modern automotive vehicle. The tire pressure and temperature can be detected using this system even in moving automobile. When the tire pressure is too high or too low, an alarm signal is transferred to the motorman. The principle of Tire Pressure Monitoring System is analyzed in this paper. Two different resolutions of TPMS are introduced. A novel pressure and temperature sensor is studied and analyzed in order to realize TPMS.

### 37、TPMS的研究和设计

张艳红 张兆华 刘理天

仪器仪表学报, 2005S1

本文简述了TPMS的基本原理、发展现状和趋势。介绍了我们设计的一种应用于汽车电子领域的胎压传感器, 该器件把压力传感器和温度传感器集成在一起, 具有结构简单, 系统温漂小和功耗低等特点。

#### Research and Design of TPMS

Zhang Yanhong Zhang Zhaohua Liu Litian

Chinese Journal of Scientific Instrument 2005 S1

In this paper, the basic theories and developments of TPMS are described, and a tire pressure sensor for vehicle application is designed. Both the pressure-sensitive component and temperature-sensitive component are integrated in this device, which has advantages such as simple structure, small temperature shift and low power dissipation.

### 38、无铅焊料

贾松良

信息产业导向, 2005年6月, 513-518

本文介绍了无铅焊料的基本类型、基本制造工艺、主要性能和参数, 各国的无铅焊料专利申请情况及国内外技术和市场的发展现状和展望。

#### Lead-Free Solder

Jia Songliang

Guide for Information Industry, Jun.2005. 513-518

This paper introduce the basic types of lead-free solder, it's basic manufacture process, mean performance and parameters,

application circumstance of lead-free solder patents in all countries, develop situation and future of technology and market in domestic and foreign countries.

### 39、集成电路封装技术与军用塑封器件

贾松良

塑封SMT研讨会, 2005年12月

本文根据各国半导体行业协会制定的2004~2015年IC单芯片封装技术的发展路线介绍了未来IC封装发展的趋势, 并对塑料封装半导体器件用于军事装备和航空、航天装置的必然性、可能性和存在的风险作了详细介绍, 并阐述了塑封的一些固有优点和缺点, 也列出了与此有关的美国的一些指导性文件。

### IC Packaging Technology and Plastic Package Devices for Ministry Application

Jia Songliang

Plastic package & SMT Seminar, Dec.2005

This paper has introduced the future developing trend of IC package, according to the 2004~2015 International Technology Roadmap for Semiconductors (ITRS), which is issued by Semiconductor Industry Association (SIA) etc. This paper also has introduced the inevitability, possibility and existed risk of that the plastic package semiconductor device can be applied in ministry and aviation and aerospace equipment in detail. Some inherent advantages and disadvantages of the plastic package has been presented, and some American relational guidance documents has been listed.

### 40、新型自适应模糊控制器及simulink混合仿真研究

单伟伟, 冯鹏, 靳东明

2005第一届Matlab&Simulink中国用户大会暨技术论坛

本文提出了基于变论域的新型自适应模糊控制器及其用HDL硬件描述语言实现的硬件结构。simulink与ActiveHDL混合仿真的模拟结果显示这种自适应模糊控制器能迅速准确的控制非线性系统使之跟踪参考输入信号, 从而验证了该VLSI(超大规模集成电路)结构能够实现预期的功能。最后提出了使用混合仿真替代集成电路设计中部分功能验证的设想, 有望减小设计周期, 降低成本。

### A Study on Novel Self-tuning Fuzzy Controller and Simulink Co-simulation

Shan Wei-wei, Feng Peng, Jin Dong-ming

First Matlab&Simulink China User Conference and Technique Forum, 2005

A novel self-tuning fuzzy controller and its VLSI implementation are developed based on variable universe of discourse. Results of simulink - ActiveHDL co-simulation indicate that this self-tuning fuzzy controller and its VLSI implementation worked successfully in controlling a nonlinear system to track a reference trajectory, which verifies that this VLSI implementation fulfills the expected functions. Finally, an idea is proposed as substituting part of the functional verification in VLSI design by using simulink - ActiveHDL co-simulation technology, thus it is hopeful to simplify the complicated time-consuming functional verification.

### 41、Investigation of composition in nano-scaled self-assembled SiGe islands

Deng N, Zhang L, Chen PY

CHINESE PHYSICS LETTERS, Vol 22, No. 7, JUL 2005, p1761-1763.

A modified model is proposed to explain the influence of Si concentration on shape transition of self-assembled SiGe islands on Si substrates. The experimental results show that the critical sizes for shape transition from pyramids to domes (44, 50 and 60nm) increase with the increasing Si concentration (0.032, 0.09 and 0.17) from sample A to C. Based on, the proposed model, the quantitative relation between the Si concentration and the critical size is established. Then the composition exactly in nano-scaled self-assembled SiGe islands is calculated from the measured critical size. The result shows that the Si concentration deduced from Raman spectrum is much larger than the actual values. It is demonstrated that the quantitative relation we obtained can be used to investigate the composition in nano-scaled SiGe islands.

### 42、Optical study of Ge Quantum Dots and Infrared Photodetectors

Rongshan Wei, Ning Deng, Minsheng Wang, Shuang Zhang, Peiyi Chen

Proceedings of 2005 5th IEEE Conference on Nanotechnology, Nagoya, Japan, July 2005, p57-59

Stacked Ge quantum dots were grown on Si(100) by ultra-high vacuum chemical vapor deposition(UHV/CVD). Obvious blueshift (87meV) observed from PL spectrum under 10K demonstrates strong quantum confinement in Ge dots. Based on the material, PIN structure quantum dot infrared photodetectors (QDIPs) were fabricated. At room temperature, I-V measurement showed a low dark current density of  $1.7 \times 10^{-6} \text{A/cm}^2$  at  $-3\text{V}$ . The maximum photocurrent responsivity of  $0.52 \text{A/W}$  at  $774 \text{nm}$  was achieved, and  $0.043 \text{mA/W}$  at  $1.31 \mu\text{m}$  was found. The dots layers were considered to trap the light in the intrinsic region, and thus increase the absorption. Finally, samples of structural optimization were proposed.

### 43、Uniform dome-shaped self-assembled Ge islands by UHV/CVD after boron pre-deposition

Deng Ning, Zhang Lei, Chen Peiyi

Materials Research Society Symposium Proceedings, Vol. 832, 2005, p 117-120

▣ The effects of pre-deposition of boron with different B<sub>2</sub>H<sub>6</sub> flux on the self-assembled growth of Ge islands Si(100) substrate by UHV/CVD are studied by atomic force microscopy (AFM). Proportion of dome-shaped Ge islands increases with the increasing of flux of B<sub>2</sub>H<sub>6</sub> [Fig 1]. Quite uniform dome-shaped Ge quantum dots with size and height distribution of less than 3% which is much more narrow than the size distribution of typical self-assembled Ge dots, are obtained after appropriate boron pre-deposition [Fig 2]. The lateral size and height of these dots are 60 and 10 nm respectively and the density is about 8E9 cm<sup>-2</sup>. Based on the shape transition model we proposed elsewhere, the uniform size and shape distribution after boron pre-deposition was explained. During the growth, boron atoms will diffuse into Ge islands. The reduced lattice mismatch results in a larger critical size for shape transition from pyramids to domes, then uniform dome-shaped Ge islands can be obtained. The results show that method of boron pre-deposition can be used to fabricate quite uniform Ge quantum dots to meet the requirements of opto-electronic devices.

#### **44、 Vibrations of an Asymmetrically Electroded Piezoelectric Plate**

Jiashi Yang, Honggang Zhou, Zheyao Wang,

IEEE Trans. on Ultrasonics, Ferroelectrics, and Frequency Control. 52(11), 2031-2038, 2005.

▣ Two-dimensional equations for coupled extensional, flexural, and thickness-shear motions of a piezoelectric plate are obtained systematically from the threedimensional equations of linear piezoelectricity by retaining lower order terms in power series expansions in the plate thickness coordinate. The plate can have asymmetric electrodes on its major surfaces. The equations are specialized to crystals of 6-mm symmetry and are used to analyze thickness-shear vibrations of an asymmetrically electroded plate. Energy trapping, a behavior of thickness-shear modes crucial to applications, is examined.

#### **45、 Design and optimization of laminated piezoresistive microcantilever sensors**

Zheyao Wang, Ruifeng Yue, Ruoxin Zhang, Litian Liu

Sensors and Actuators. A, 120(2), 2005: 325-336.

▣ Microcantilevers-based sensors (MCSs) are a new approach to detecting and measuring physical, chemical, and biological signals in the nano- to femto-range level. Piezoresistive readout systems for MCSs have the advantages of full integration, low cost, ease of use, and the capability of manipulating large arrays. This paper presents a design method for laminated piezoresistive MCSs to obtain optimal performance by optimizing the dimensions of the microcantilevers and the doping concentration of the piezoresistors. Laminated theory was employed to deduce the closed-form solutions to static stress and natural frequency. Expressions for predicting sensitivity and resolution were derived by combining stress distribution with power densities of 1/f noise and Johnson noise. Finite element method (FEM) was performed to verify the theoretical results. The thickness of the laminated MCSs and the doping concentration were optimized by using static analyses and power densities of noise to generate the best sensitivity and resolution. A method based on non-linear programming is given to facilitate the solving process. These methods and some conclusions are also applicable to developing other types of piezoresistive sensors that use laminated structures.

#### **46、 Analysis and Optimization of a Compliant Mechanism- Based Digital Force/Weight Sensor**

Zheyao Wang, Huan Hu

IEEE Sensors Journal, 5(6), Dec. 2005, 1243 – 1250.

▣ Digital force/weight sensors have some advantages over their analog counterparts. This paper describes the optimization and implementation of a novel digital force/weight sensor that uses a thickness shear quartz crystal resonator (QCR) and a unique compliant mechanism. The compliant mechanism consists of eight flexure hinges and is used to fix the sensitive QCR and transfer the measured force. Advantages of such a sensor include inherent digital output, high resolution, high reliability, and low cost. Due to the complex structure and the multivariables of the compliant mechanism, conventional trial methods are inefficient in determining the dimensions. To solve this problem, an optimization method has been developed by employing rigid-body model, finite element method, and nonlinear programming techniques. Experimental results show that it is more efficient than trial methods in optimizing complex compliant mechanism-based sensors. This method can be used as a generic method for optimizing force sensors using compliant mechanisms, to obtain the desired specifications.

#### **47、 Fabrication of organic PVP doping-based Ba<sub>0.5</sub>Sr<sub>0.5</sub>TiO<sub>3</sub> thick films on silicon substrates for MEMS applications**

Zheyao Wang, Jianshe Liu, Tian-Ling Ren, Litian Liu

Sensors and Actuators. A, 2005, 117(2): 293-300

▣ Barium strontium titanate (Ba<sub>x</sub>Sr<sub>1-x</sub>TiO<sub>3</sub>, BST) films have been used to develop microwave devices, microsensors, and RF MEMS devices due to the tunable dielectric properties, high dielectric constant, and low loss tangent. However, the most commonly used sol-gel method for BST film preparation has the problem of crack formation. This paper presents a modified sol-gel method to realize crack-free thick films on silicon substrates. The method uses organic macromolecular poly(vinylpyrrolidone) (PVP) dispersed uniformly into the sol-gel precursor solution to avoid crack formation. Due to the hybrid effect of PVP, thick films with thickness up to 1 micron can be achieved by multiple repetitive spin coating and sol-gel method. The preparation process is given in detail, and the effects of PVP and anneal temperature on the maximum film thickness are discussed. The thick films are characterized at frequencies up to 26.5 GHz by using coplanar waveguides. Experimental results show that this method is effective in preparing BST thick films, in particular for porous BST thick films for sensor and RF MEMS applications.

**48、 Study of a ferroelectrics-silicon integrated microspeaker and microspeaker array**

Yi-Ping Zhu, Tian-Ling Ren, Yi Yang, Li-Tian Liu, Zhi-Jian Li

Integrated Ferroelectrics, 2005, 69 (1): 357-366.

■ A novel ferroelectrics-silicon integrated microspeaker and microspeaker array is proposed. The Al/SiO<sub>2</sub>/Pt/Pb(Zr,Ti)O<sub>3</sub>/Pt/Ti/SiO<sub>2</sub> multimorph structure is designed and fabricated. The microspeaker based on this multimorph structure has high output acoustic pressure, and the displacement at the center of membrane is very high. This structure designed in the single microspeaker can also be used in microspeaker array. After optimization of the position of the electroacoustical transducer cells, the realized microspeaker array can reach the high output acoustic power and good transducing directivity. This integrated microspeaker and microspeaker array will be widely used for audio frequency and ultrasonic frequency devices.

**49、 Design of A Novel Piezoelectric Acoustic Sensor Using Surface Micromachining**

Yi Yang, Tian-Ling Ren, and Li-Tian Liu

The 17th International Symposium on Integrated Ferroelectrics

■ A novel structure of piezoelectric acoustic sensors using surface micromachining is proposed and designed. The advantage of surface micromachined acoustic sensors is to reduce the device size while maintaining their good performances compared with bulk micromachined counterparts. The simplified process sequence for the fabrication of acoustic sensors is given and porous silicon is used as a thick sacrificial layer. The PZT-based piezoelectric acoustic sensors exhibit a voltage sensitivity of 61 to 474  $\mu\text{V}/\text{Pa}$ , depending on geometry, which ranges from 200 to 500  $\mu\text{m}$  in length of the square membrane.

**50、 Study on the Operational Mechanism of a-Si TFT Room Temperature InfraRed Detector**

LIU Xing-Ming, HAN Lin, LIU Li-Tian

LASER &amp; INFRARED, v35, n10, 2005

■ The a-Si thin film transistor(TFT) used as room temperature infrared(IR) detector is studied. The channel current of a-Si TFT changes linearly with the ratio of width to length (W/L), which is proved by simulation and experiment respectively. The temperature dependence of a-Si TFT current is theoretically analyzed. Based on the simulation and experiment, increasing W/L does not influence the temperature coefficient of current (TCC). However, larger W/L improved the detectivity evidently, which presents the orientation of a-Si TFT infrared detector design optimization.

**51、 Effect of surface roughness of dielectric layer on the isolation of RF MEMS switch**

Lei Xiaofeng, Liu Zewen, Xuan Yun, Wei Jia, Li Zhijian, Liu Litian

Journal of Tsinghua University, accepted

■ A study on the surface roughness of dielectric layer on different electrodes and its effect to the isolation of radio-frequency micromechanical (RF MEMS) switches is presented in this paper. The study is based on a double-bridge capacitive RF MEMS switch. In this switch SiN is used as the dielectric layer and the lower electrode is fabricated with gold and aluminum respectively. The RF network measurement shows that isolation performance of two switches is very different. The surface roughness of SiN dielectric layer on different metallic electrode is measured with atomic force microscopy and the roughness Ra is 13.050nm for SiN/Au and 66.680nm for SiN/Al respectively. The corresponding degradation factors of off-state capacitance for the two electrodes are 0.52 and 0.15. The roughness less than 5nm is needed to obtain good isolation performance.

**52、 Design and Fabrication of X-band Capacitive MEMS Switches**

Lei Xiaofeng, Liu Zewen, Xuan Yun, Wei Jia, Li Zhijian, Liu Litian

Journal of Electron Devices, accepted

■ Design and fabrication of a novel X-band capacitive RF MEMS switch is reported. The switch consists of a suspended metallic membrane supported by the like-coil structure over the coplanar waveguide. The equivalent inductance of the like-coil structure is 134pH, which greatly decrease the off-state resonate frequency of the switch. The design is optimized based on a series of simulations, which is realized with commercial EDA tools. The simulations show that the proposed switch structure present better isolation than traditional switch in relative low RF frequency (X band). This switch is made using silicon surface micromachining process. On wafer measurement results have been carried out. The threshold voltage is less than 9V, the insertion loss is 0.69dB@11.6GHz, and the isolation is 27.7dB@11.6GHz.

**53、 Study on a novel 3-resonance capacitive RF MEMS switch**

Lei Xiaofeng, Liu Zewen, Li Zhijian, Liu Litian

Research and Progress of Solid State Electronics, accepted

■ A modified equivalent circuit for capacitive RF MEMS and a novel switch design based on the modified equivalent circuit is presented. Analysis shows that the traditional RLC series circuit model is incomplete when capacitive switch has multiple support beams. Simulation results show that the multi-resonance switch can work in multiple frequency bands and has very good isolation in low frequency. A 3-resonance switch is designed and fabricated on high-resistivity silicon substrate. The actuation voltage of the fabricated 3-resonate point switch is 7V, and the insertion loss is 0.69dB@10.4GHz, the isolation is 30.8dB@10.4GHz. The performance is far better than traditional single-resonance switch at frequency lower than 13.5GHz.

**54、 High quality silicon-based AlN thin films for MEMS application**

Yu Y, Ren Tian-Ling, Liu LT

INTEGRATED FERROELECTRICS 69: 367-374 2005

Aluminum nitride is an attractive piezoelectric material for MEMS devices such as bulk acoustic wave (BAW) devices. (002) oriented AlN films were deposited on Si, Al and Pt by reactive sputtering. Optimized AlN (002) peak reaches a full width at half maximum (FWHM) of 5.6 degrees. Auger electron spectroscopy is used to analyze the oxygen contamination of films. To find the suitable electrode material for device application, the growth mechanism of AlN crystallites on different substrates is also discussed. Based on sputtered AlN films, the prototype of AlN thin film bulk acoustic resonator (TFBAR) was fabricated successfully.

### 55、Nondestructive Evaluation of MEMS Devices by Laser Confocal Measurements

Xiao-ming WU, Ning-xin ZHANG, Tian-ling REN, Li-tian LIU

Proceedings of the 2005 International Conference on MEMS, NANO and Smart Systems (ICMENS'05),

This paper proposes an innovative nondestructive evaluation (NDE) setup for MEMS mechanical deformation measurements. The setup is based on an active laser confocal displacement meter, and a computer controlled motor-driven 3-dimension (3D) stage. The out-of-plane measurement resolution of the scanning confocal setup is 0.1  $\mu\text{m}$ . The maximum measurement range is 0.3mm out-of-plane and 60mm by 60mm in plane, respectively. The principle of the measurement method is introduced briefly. A multilayer piezoelectric acoustic MEMS membrane was fabricated and measured by using this setup. The profile of membrane was estimated. Nonlinear response feature of the membrane to direct current bias voltage was observed. The residual stresses of individual layer of the membrane were estimated according to Stoney's theory. The test results gave quantificational description of MEMS membrane deformation, which can guide the optimal design of the acoustic devices. The laser confocal technique proved to be a valuable micro-NDE characterization tool.

### 56、Measurements of Ferroelectric MEMS Microphones

Xiaoming Wu, Yi Yang, Jian Cai, Tianling Ren, and Litian Liu

Integrated Ferroelectrics, 69: 417-429, 2005

This paper introduces three measurement methods of ferro-MEMS microphone in the fields of acoustics, piezoelectronics and mechanics respectively. The results of the three measurements are close to each other in some respects, such as frequency response, resonant frequency, quality value and so on. And they together discover the total characteristics of ferro-MEMS microphone which is hard to be obtained in only one measurement. Especially, a typical TO-CAN packaged ferro-MEMS microphone is presented and coupler measurement technology is discussed for acoustics measurement. Resonance measurement and vibration measurement of microphone membrane are taken mainly to confirm the resonant frequency and frequency response of microphone membrane. All measurement results agree well with theoretical estimation. In the case of ferro-MEMS microphone with membrane size of 2.5 mm  $\times$  2.5 mm, the resonant frequency of membrane is 13 kHz, quality factor is about 8. And the sensitivity of the microphone is -36 dB(15 mV/Pa)@1 kHz.

### 57、A Novel Self-Tuning Fuzzy Logic Controller Based on Variation of Universe of Discourse

Shan Weiwei<sup>1</sup>, Xu Zhihao, Jin Weiwei, Zhang Xun and Jin Dongming

The 11th World Congress of International Fuzzy Systems Association (IFSA 2005)

July 28-31, 2005, Beijing, China, Proceedings: 730-734.

In this paper, novel self-tuning methodologies of fuzzy logic controllers (FLC) are presented. Based on physical meaning of the variation of universe of discourse (UOD) and the law of PID control, a novel self-tuning fuzzy logic controller is constructed. In order to improve the performance in transient and steady state, a contraction-expansion factor is applied before each input of a conventional FLC and a self-tuning gain factor after the output. Results of matlab simulations indicate that this kind of self-tuning fuzzy logic controller worked successfully in controlling nonlinear systems to track a reference trajectory.

### 58、Self-Adaptive Domain Mapping Fuzzy Controller with Hardware Implement

Zhang Xun, Wang Peng, Jin Dongming

The 11th World Congress of International Fuzzy Systems Association (IFSA 2005)

July 28-31, 2005, Beijing, China, Proceedings: 756-759.

The design of a novel domain adaptive fuzzy logic controller is presented in this paper, which adds a domain adaptive structure on the architecture of an original fuzzy logic controller. The circuit used to form domain mapping gene is designed in this paper. It saves the hardware consumption, and accelerates the system convergence. The domain mapping fuzzy logic controller is successfully applied to control the inverted pendulum on a hardware test-bed. The experiment reveals that that improved robustness with shorter design cycle can be achieved by integrating domain mapping structure into a fuzzy logic controller. The theory and optimization of the method are also discussed. According to this strategy, a circuit can generate domain mapping gene is realized by CSMC 0.6um mixed-signal technology. It is found out that the results of the theory and the experimentation are consistent with each other well. Because the configuration is simple, this approach provides a valuable theory basement to the implement of self-adaptive fuzzy controller hardware chip in the future.

### 59、The Hardware Design of A Multi-Resolution Combined Fuzzy Min-Max Classifier

Fan Siqiang, Jin Weiwei, Zhang Xun, Jin Dongming

The 11th World Congress of International Fuzzy Systems Association (IFSA 2005)

July 28-31, 2005, Beijing, China, Proceedings: 1450-1453.

This paper put forward a scheme for the first time to design Multi-Resolution Combined Fuzzy Min-Max Classifier (MRC-FMMC)

with a parallel structure so as to increase the classification speed. Using parallel classification logic modules with a controller to classify different patterns at one time we can get several results simultaneously. The classification logic modules are unattached and the number of them is optional. The I/Os between the control logic modules and the classification logic modules are asynchronous. So they can work under different frequencies. The processor has been designed and implemented by ASIC and the post-simulation result is coincident with the software simulation. Since the classification logic cells are optional, the number of them can be decided by the system. Then, a classifier adaptive to different conditions is achieved.

### **60、Improved Blocks for CMOS Analog Neuro-Fuzzy Network**

Wang Weizhi, Jin Dongming

First International Conference on Natural Computation (ICNC'05)

August 27 -29, 2005, Changsha, China ,Proceedings, Part III: 1022-1031

▣ This paper proposed several improved CMOS analog circuits for neuro-fuzzy network, including Gaussian-like membership function circuit, minimization circuit, and a centroid algorithm defuzzier circuit without using division. And then a two-input/one-output neuro-fuzzy network composed of these circuits is implemented and testified as a non-linear function approximating. HSPICE simulation results show that all the proposed circuits provide characteristics of high operation capacity, high speed, simple structures, and high precision.

### **61、Design Of An Analog Adaptive Fuzzy Logic Controller**

Xu Zhihao, Jin Dongming, and Li Zhijian

Second International Conference on Fuzzy Systems and Knowledge Discovery (FSKD'05)

August 27-29, 2005, Changsha, China ,Proceedings, Part I : 1034-1043.

▣ An analog Adaptive fuzzy logic controller is proposed. This controller is based on back-propagation algorithm, and has the capability of on chip learning. This adaptive fuzzy logic controller was composed of an analog fuzzy logic controller and a learning circuit that realize online learning mechanism. It can tune the consequent parameters automatically with the help of a direction signal. Hspice simulation of functional approximation experiment was held, showing that this controller can realize the designed capability.

### **62、VLSI Implementation of a Self-tuning Fuzzy Controller Based on Variation of Universe of Discourse**

Shan Weiwei, Jin Dongming, Jin Weiwei, and Xu Zhihao

Second International Conference on Fuzzy Systems and Knowledge Discovery (FSKD'05)

August 27-29, 2005, Changsha, China ,Proceedings, Part I :1044-1052.

▣ A novel self-tuning fuzzy controller and its VLSI implementation are developed based on variation of universe of discourse. This fuzzy controller is constructed by applying a contraction factor before each input of a conventional fuzzy controller, and a self-tuning gain factor after its output, while all the factor are adjusted with the input variables according to a simplified adaptive law. This fuzzy controller has some features: the contraction factors and output gain factor that improve the performance of the controller are based on variable universe of discourse; these factors are simplified for VLSI implementation; only the active rules are processed and the division in the operation of COA defuzzification is omitted by setting the denominator equal to 1. Results of Matlab – Active HDL co-simulations indicate that this self-tuning fuzzy controller works successfully in controlling a nonlinear system to track a reference trajectory.

### **63、VLSI Architectures of Domain Adaptive Fuzzy Logic System**

Zhang Xun, Wang Peng, Jin Dongming

2005 6<sup>th</sup> International Conference On ASIC (ASICON 2005)

Shanghai,China October 24-27,2005,Proceedings, Book 1 of 2: 318-321

▣ A novel domain adaptive fuzzy logic controller is presented in this paper, which adds a domain adaptive structure on the architecture of an original fuzzy logic controller. It saves the hardware consumption, and accelerates the system convergence. The domain mapping fuzzy logic controller is successfully applied to control the inverted pendulum on a hardware test-bed. The theory and optimization of the method are also discussed. According to this strategy, a circuit can generate domain mapping gene is realized by CSMC 0.6 $\mu$ m mixed-signal technology. This approach provides a valuable theory basement to the implement of self-adaptive fuzzy controller hardware chip.

### **64、Circuit Design of an Improved Approximate Squaring Function**

Zhang Xun, Jin Weiwei, Jin Dongming

2005 6<sup>th</sup> International Conference On ASIC (ASICON 2005)

Shanghai,China October 24-27,2005,Proceedings, Book 2 of 2: 1059-1061.

▣ An improved approach to design the approximate squaring function is presented in this paper. It is implemented through a simple combinational logic circuit with fewer transistors. In addition, the maximum relative error (MRE) and average relative error (ARE) of squaring approximation are both improved compared with the previous methods. The algorithm is implemented by a VLSI design of 7-bit approximate squaring function.

### **65、A micro direct methanol fuel cell using PDMS assembly technology**

Jiang Yingqi, Wang Xiaohong, Xie Kewen, Qiu, Xinping, Zhong Lingyan, Liu Litian.

The 13th International Conference on Solid-State Sensors and Actuators and Microsystems (TRANSDUCERS '05) ,



2005

☐ This paper presents the fabrication of a micro direct methanol fuel cell, featured by MEMS technology and using Polydimethylsiloxane (PDMS) as the package material. The detailed fabrication processes, including an original set of assembly steps, are reported. The testing results show that the open circuit potential of the prototype with the active area of  $8.6\text{mm}\times 8.6\text{mm}$  is  $0.5\text{V}$ , and the maximum power density is  $3.86\text{mW}/\text{cm}^2$  using  $1\text{M}$  methanol feed at room temperature. The PDMS package has prevented the fuel cell from any leakage during the daylong test, demonstrating that MEMS fabrication with the assistance of PDMS can be a promising way for the developing of the micro direct methanol fuel cell ( $\mu\text{DMFC}$ ).

### **66、Design, fabrication, and testing of a silicon-based air-breathing micro direct methanol fuel cell**

Yingqi Jiang, Xiaohong Wang, Xinpeng Qiu, Lingyan Zhong, Yan'an Zhou, Zhichun Wang, Litian Liu

The Fifth International Workshop on Micro Nanotechnology for Power Generation and Energy Conversion Applications (PowerMEMS'05), 2005.

☐ This paper reports the design, fabrication and testing of a silicon-based air-breathing  $\mu\text{DMFC}$  featured by the unique cathode structure and utilization of MEMS technology. The idea that leads to the cathode design is introduced and the detailed fabrication process is presented. The experimental results show the prototype had an open-circuit potential of  $0.47\text{V}$  and a power density of  $2.31\text{mW}/\text{cm}^2$  when fed with  $1\text{M}$