

## ELECTRICAL SIMULATION OF A p-i-n IMAGE SENSOR

J. Martins; M. Fernandes; M. Vieira

Instituto Superior de Engenharia de Lisboa.

**Publicado em:** *Vacuum*, vol. 64(3-4), pp. 307-313, Elsevier Science LTD, Oxford, IDS Number: 510HH, ISSN: 0042-207X, January, 2002.

We have modelled a p-i-n image sensor under local illumination through a two-dimensional non-linear circuit. The sensor is described as an array of photodiodes interconnected through lateral resistors, which model the sheet resistance of the doped layers. Under small-signal analysis a current-controlled resistor proportional to the inverse of the photocurrent models each photodiode. A SPICE based simulator is used as a tool to analyse the sensor output characteristics. Several configurations and contact geometries are analysed for the image transducer. The image responsivity, the spatial resolution and the image distortion are modelled by changing the ratio between the transversal and the lateral resistors or the acquisition points. Results show that the geometry and location of the contacts affect the distortion of the restored image. The conductivity of the doped layers and the light flux illumination influences the image resolution and accuracy. The simulated and experimental results were found in a good agreement.

## PROPERTIES OF HIGH GROWTH RATE AMORPHOUS SILICON DEPOSITED BY MC-RF-PECVD

G. Lavareda<sup>a</sup>; CN de Carvalho<sup>a</sup>; A. Amaral<sup>a,c</sup>; JP Conde<sup>d</sup>; M. Vieira<sup>e</sup>; V. Chu<sup>f</sup>

<sup>a</sup>UTL, Centro de Física Molecular, IST, Lisboa, Portugal; <sup>b</sup>Universidade Nova de Lisboa, Faculdade de Ciências e Tecnologia; <sup>c</sup>UTL, DF, Lisboa, Portugal; <sup>d</sup>UTL, DEM, IST, Lisboa, Portugal; <sup>e</sup>Instituto Superior de Engenharia de Lisboa; <sup>f</sup>Instituto Engenharia de Sistemas e Computadores, Lisboa, Portugal.

**Publicado em:** *Vacuum*, vol. 64(3-4), pp. 245-248, Elsevier Science LTD, Oxford, IDS Number: 510HH, ISSN: 0042-207X, January, 2002.

Hydrogenated amorphous silicon (a-Si 11) thin films have been deposited on glass and crystalline silicon substrates by magnetically confined RF-PECVD (MC-RF-PECVD) at different RF power densities in order to verify the influence of this deposition parameter on the density of states (DOS) and growth rate (R-G). It was found that the highest growth rate, 7.8 Angstrom/s, is obtained for a-Si:H films deposited with an RF power density of 14.3 mW/cm<sup>3</sup>. For the DOS calculation, constant photocurrent method (CPM) data have been used. The lowest value of DOS is approximately  $8 \times 10^{15}$  eV/cm<sup>3</sup> and was obtained for a-Si:H films produced with an RF power density in the range of 10-20 mW/cm<sup>3</sup>. Infrared spectroscopy shows that when the RF power density increases, the concentration of SiH<sub>3</sub> groups decreases and the concentration of SiH groups increases. At 8 mW/cm<sup>3</sup>, a maximum of the SiH<sub>2</sub> concentration is obtained. At this point, a maximum of the optical gap (1.9 eV) is observed and a minimum of the dark conductivity is verified. We conclude that the best films are achieved in an RF power density range (7.1-21.4 mW/cm<sup>3</sup>) for which an increase of SiH and a decrease of both SiH<sub>2</sub> and SiH<sub>3</sub> are simultaneously obtained. Thereafter, for higher power densities, an inversion of DOS and growth rate behaviour are observed due to ion bombardment.

#### MODELLING a-Si:H BASED p-i-n STRUCTURES FOR OPTICAL SENSOR APPLICATIONS

Y. Vygranenko; M. Fernandes; P. Louro; M. Vieira

Instituto Superior de Engenharia de Lisboa.

**Publicado em:** *Thin Film Solids*, vol. 403-404, pp. 354-358, Elsevier Science SA, Lausanne, IDS Number: 525DQ, ISSN:0040-6090, February, 2002.

This paper presents a 1-D numerical simulation of the charge carrier transport and photogeneration in a-Si:H based p-i-n homo- and heterostructures. These structures with a special doping profile are used as the sensing element in Laser Scanned Photodiode image sensors. The effect of the carbon contents and doping profile on the junction characteristics are investigated and correlated with experimental data. Results show that the image sensitivity can be improved by increasing the doping level in the front p-layer and keeping the conductivity of the

back n-layer in the range  $10^{-10}$ – $10^{-12}$   $\text{cm}^{-3}$ . The highest image sensitivity is achieved when a wide-gap a-SiC:H alloy is used as interface material since the electron density in the back layer can be reduced down to the free carrier concentration in the a-Si:H i-layer. Detailed simulation studies have been carried out at different light intensities and bias voltage. The band diagrams, electric field distribution, free carrier population, generation-recombination profiles, and electron and hole current densities are analysed. Results show that as the light intensity increases the potential drop across the a-SiC:H back layer becomes dominant leading to a significant change in the drift-diffusion balance along the i-layer. In the homojunction even at high light fluxes the transport process remains drift dominated.

### MEMORY EFFECTS IN HIGHLY RESISTIVE p-i-n HETEROJUNCTIONS FOR OPTICAL APPLICATIONS

R. Schwarz<sup>a,b</sup>; P. Louro<sup>a</sup>; Y. Vygranenko<sup>a</sup>; M. Fernandes<sup>a</sup>; M. Vieira<sup>a</sup>; M. Schubert<sup>c</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>Departamento de Física, IST, Portugal; <sup>c</sup>Institut für Physikalische Elektronik, IPE, Universität Stuttgart, Germany.

**Publicado em:** *Thin Film Solids*, vol. 403-404, pp. 363-367, Elsevier Science SA, Lausanne, IDS Number: 525DQ, ISSN: 0040-6090, February, 2002.

Large area p-i-n diode structures based on amorphous hydrogenated silicon can be used as single element image sensors where the information is read out by a scanning laser beam. A high sensitivity is reached with silicon-carbon alloy contact layers. The higher defect density in the large band gap material is usually a problem for efficient carrier collection in solar cell applications. When used as an image sensor, however, the charge stored in deep defects represents an easy way to realize short-term image storage. In the case of a p-(Si:H)/i-(Si:H)/n-(Si<sub>x</sub>C<sub>1-x</sub>:H) sensor structure we have measured a memory effect of about 1 % after several minutes of image projection. Metastable sensor degradation is observed in accordance with the Staebler-Wronski effect. Fast degradation of sensor performance – corresponding to 90 % erasable image storage capability - was studied in an unalloyed structure using a Nd:YAG laser system. The response can be modelled by a stretched exponential decay with parameters depending on the laser pulse energy.

## SURFACE-BARRIER ITO/SiO<sub>x</sub>/Si OPTICAL SENSOR WITH INTERNAL GAIN

M. Fernandes<sup>a</sup>; A. Fantoni<sup>a</sup>; Y. Vygranenko<sup>a</sup>; R.Schwarz<sup>a</sup>; M.Vieira<sup>a</sup>; C. Nunes Carvalho<sup>b</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>CFM/UTL, Lisboa, Portugal.

**Publicado em:** *Vacuum*, vol. 65(1), pp. 67-71, Elsevier Science LTD, Oxford, IDS Number: 525ET, ISSN: 0042-207X, February, 2002.

Indium-tin-oxide (ITO)/SiO<sub>x</sub>/n-Si/metal structures have been fabricated in order to develop a low temperature processing technique for production of high quantum efficiency and low-cost photodiodes. High-quality ITO film was deposited by reactive thermal evaporation at a low substrate temperature ( $383\text{ K} < T_s < 473\text{ K}$ ) and acts as an effective collector of the photo-generated carriers and antireflection layer, simultaneously. The junction properties and carrier transport are investigated from dark and illuminated current-voltage and capacitance-voltage characteristics. A significant photocurrent amplification has been observed under reverse bias conditions in the photodiodes having high-resistivity substrate ( $10^3\text{ cm}$ ). Sensitivities up to 30 A/W were reached at  $0.63\text{ m}$ . The photocurrent amplification effect is attained only when both reverse bias voltage and radiation flux overcomes the threshold values.

## LASER SCANNED PHOTODIODES (LSP) FOR IMAGE SENSING

M. Vieira<sup>a</sup>; M. Fernandes<sup>a</sup>; Y. Vygranenko<sup>a</sup>; P. Louro<sup>a</sup>; R. Schwarz<sup>a</sup>; M. Schubert<sup>b</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>Institut für Physikalische Elektronik, Universität Stuttgart, Germany.

**Publicado em:** *Sensors and Actuators A-Physical*, vol. 97-98, pp. 98-103, Elsevier Science SA, Lausanne, IDS Number: 564CG, ISSN: 0924-4247, April, 2002.

An optimized ZnO:Al/a-pin SixC<sub>1-x</sub>:H/Al configuration for the laser scanned photodiode (LSP) imaging detector is proposed and the read-out parameters improved. The effect of the sensing element structure, cell configuration and light source flux are investigated and correlated with

the sensor output characteristics. Data reveals that for sensors with wide band gap doped layers an increase on the image signal optimized to the blue is achieved with a dynamic rate of two orders of magnitude, a sensitivity of 6 mA/W and a responsivity of  $17 \text{ Wcm}^{-2}$  at 530 nm. The main output characteristics such as image responsivity, resolution, linearity and dynamic range were analyzed under reverse, forward and short circuit modes. The results show that the sensor performance can be optimized in short circuit mode. A trade-off between the scan time and the required resolution is needed since the size of the spot limits the resolution due to the cross-talk between dark and illuminated regions leading to blurring effects.

### BIOMETRIC SYSTEM BASED ON ONE SINGLE LARGE AREA a-SiC:H p-i-n PHOTODIODE

M. Vieira; M. Fernandes; A. Fantoni; P. Louro; R. Schwarz

Instituto Superior de Engenharia de Lisboa.

**Publicado em:** *Proceedings of Material Research Society Symposium, MRS Conference, S. Francisco, USA, April, 2002.*

Based on the Laser Scanned Photodiode (LSP) image sensor we present an optical fingerprint reader for biometric authentication. The device configuration and the scanning system are optimised for this specific purpose. A laser light illuminates the fingerprint placed on a glass surface in front of the capture device. The reflected light coming from the glass is projected onto the active surface of the sensing element (large area a-SiC:H p-i-n photodiode). The image is converted directly into a proportional electric current using the LSP as fingerprint reader. In this work the main emphasis will be put on the influence of the doped layers (doping level, carbon content) of the active layer (photosensitivity, defect density, temperature dependence, thickness) on the device performance (transfer functions, sensitivity, dynamic range, resolution, linearity, responsivity, response time). The scanning technique for fingerprint acquisition will be improved and the effects of the probe beam size, wavelength and flux, the scan time and modulation frequency on image contrast and resolution will be analysed under different electrical bias. An optical model of the image acquisition process is presented and

supported by a two dimensional simulation. Results show that a trade-off between read-out parameters (fingerprint scanner) and the biometric sensing element structure (p-i-n structure) are needed to minimize the cross talk between the fingerprint ridges and the fingerprint valleys. The performance of the capture device is enhanced by a tight control of image brightness and applied electrical bias. In the heterostructures with wide band gap/low conductivity doped layers the user-specific information is detected with a good contrast while the resolution of the sensor is around 20  $\mu\text{m}$ . A further increase in the contrast is achieved by slightly reverse biasing the sensor with a sensitivity of  $6.5 \text{ Wcm}^{-2}$  and a flux range of two orders of magnitude.

### DYNAMIC RESPONSE OF NON-PIXELED AMORPHOUS SILICON BASED IMAGE SENSORS

M. Fernandes; Y. Vygranenko; M. Vieira

Instituto Superior de Engenharia de Lisboa.

**Publicado em:** *Proceedings of Material Research Society Symposium, MRS Conference, S. Francisco, USA, April, 2002.*

Large area hydrogenated amorphous silicon p-i-n structures with low conductivity doped layers were proposed as single element image sensors. The image acquisition technique consists in using a modulated light beam to scan the sensor active area and recording the photoresponse in each scanning position. This work is focused on the analysis of the dynamic behavior of this type of sensor and to infer some sensor parameters like maximum scanning speed, from which depends the maximum achievable frame rate. In order to evaluate the sensor response to a time varying light excitation the sensor was locally illuminated with a focused chopped light source and the generated photocurrent was measured under different load conditions. Results show that the sensor is mainly capacitive and a signal rise time of approximately 100  $\mu\text{s}$  was measured under a 1 k $\Omega$  load. Capacitance-Voltage measurements were also performed in order to evaluate the change in capacitance with uniform illumination. A model for the sensor was created from the experimental data and this model was used to simulate the dynamic behavior of the sensor. The simulation results obtained are in good

agreement with the experimental ones. As conclusion one can expect a trade off between the frame rate and the number of pixels. A frame rate higher than 10 fps was achieved for 100 100 pixels readout without a significant degradation in the image quality.

### A NEW CLSP SENSOR FOR IMAGE RECOGNITION AND COLOR SEPARATION

M. Vieira; M. Fernandes; A. Fantoni; P. Louro; R. Schwarz

Instituto Superior de Engenharia de Lisboa.

**Publicado em:** *Proceedings of Material Research Society Symposium, MRS Conference, S. Francisco, USA, April, 2002.*

Large area p-i-n a-SiC:H heterostructures are used as LSP color sensors. For reading out the color signals, three appropriated voltages have to be successively applied in order to combine afterwards the information to yield a color image. The highly resistive and wide band gap doped layers confine the photogenerated carriers at the illuminated regions and driven by the scanner extract information on the image range and intensity. The forward bias controls the absorption and the electric field across the main generation region. As the applied bias increases the reversed electrical field in the bulk shifts toward the main generation regions, and successively suppresses the ac component of the photocurrent at each primary color allowing color extraction. The device performance is analyzed and the scanning technique for color separation improved. The effects of the bias on image contrast, resolution and color extraction are discussed. A physical model for image and color recognition is presented and supported by a two dimensional simulation.

### PHOTOCARRIER RESPONSE TIME SCANNER

R. Schwarz<sup>a,b</sup>; M. Fernandes<sup>a</sup>; A. Fantoni<sup>a</sup>; M. Vieira<sup>a</sup>; P. Ferreira<sup>b</sup>; P. Sanguino<sup>b</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>Physics Department, Instituto Superior Técnico, Portugal.

**Publicado em:** *J. Non Crystalline Solids, vol. 299, pp. 1261-1266, Part B, Elsevier Science BV, Amsterdam, IDS Number: 554VJ, ISSN: 0022-3093, April, 2002.*

We have used the dependence of the response time after short laser pulses on background light intensity in hydrogenated microcrystalline silicon to study some preliminary properties of a 2-D image sensor application. The coplanar readout scheme has the advantage of a simple sample structure, however, the signal-to-noise ratio is acceptable only in the perpendicular readout of a p-i-n detector. The response time map reflects the change of both the resistivity and capacitance under varying local illumination. A camera speed of 10 frames per second with a 50 by 50 pixel resolution is reached on a  $2 \text{ cm}^2$  detector.

### BIAS DEPENDENT PHOTOCURRENT COLLECTION IN p-i-n a-Si:H/SiC:H HETEROJUNCTION

P. Louro<sup>a</sup>; M. Vieira<sup>a</sup>; Y. Vygranenko<sup>a</sup>; M. Fernandes<sup>a</sup>; R. Schwarz<sup>a</sup>; M. Schubert<sup>c</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>Institut für Physikalische Elektronik, Universität Stuttgart, Germany.

**Publicado em:** *Sensors and Actuators A-Physical*, vol. 97-98, pp. 221-226, Elsevier Science SA, Lausanne, IDS Number: 564CG, ISSN: 0924-4247, April, 2002.

A series of large area single layers and glass/ZnO:Al/p ( $\text{Si}_x\text{C}_{1-x}:\text{H}$ )/i (Si:H)/n ( $\text{Si}_x\text{C}_{1-x}:\text{H}$ )/Al ( $0 < x < 1$ ) heterojunction cells were produced by PE-CVD at low temperature. Junction properties, carrier transport and photogeneration are investigated from dark and illuminated current-voltage and capacitance-voltage characteristics. For the heterojunction cells atypical J-V characteristics under different illumination conditions are observed leading to poor fill factors. High series resistances around  $10^6$  are also measured. These experimental results were used as a basis for the numerical simulation of the energy band diagram, and the electrical field distribution of the structures. Further comparison with the sensor performance gave satisfactory agreement. Results show that the conduction band offset is the most limiting parameter for the optimal collection of the photogenerated carriers. As the optical gap increases and the conductivity of the doped layers decreases, the transport mechanism changes from a drift to a diffusion-limited process.

## IMAGE CAPTURE DEVICES BASED ON p-i-n SILICON CARBIDES FOR BIOMETRICS APPLICATIONS

M. Vieira<sup>a</sup>; M. Fernandes<sup>a</sup>; P. Louro<sup>a</sup>; Y. Vygranenko<sup>a</sup>; A. Fantoni<sup>a</sup>; R. Schwarz<sup>a</sup>; M. Schubert<sup>b</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>Institut für Physikalische Elektronik, Universität Stuttgart, Germany.

**Publicado em:** *Journal of Non Crystalline Solids*, vol. 299, pp. 1245-1249, Part B, Elsevier Science BV, Amsterdam, IDS Number: 554VJ, ISSN: 0022-3093, April, 2002.

The Laser Scanned Photodiode (LSP) image sensor is optimized and used as a biometric (fingerprint) reader. A laser light illuminates the fingerprint placed on a glass surface in front of the sensor. The reflecting light coming from the glass is projected onto the active surface. The image is converted directly into a proportional electric current using the LSP as fingerprint scanner. Results show that a trade-off between read-out parameters (fingerprint scanner) and the biometric sensing element structure (p-i-n structure) is needed to minimize the cross talk between the fingerprint ridges (dark regions) and the fingerprint valleys (illuminated regions). In the optimized configuration and under reverse bias the user-specific information *minutiae* present a good contrast and a spatial resolution of 20  $\mu\text{m}$ . An increased light to dark sensitivity, a flux range of two orders of magnitude and a responsivity lower than  $65 \text{ Wcm}^{-2}$  were obtained under reverse voltage.

## ANALYSIS OF THE BIAS DEPENDENT SPECTRAL RESPONSE OF a-SiC:H p-i-n PHOTODIODE

P. Louro; A. Fantoni; Y. Vygranenko; M. Fernandes; M. Vieira

Instituto Superior de Engenharia de Lisboa.

**Publicado em:** *Proceedings of Material Research Society Symposium, MRS Conference, S. Francisco, USA, April, 2002.*

Up to now the physics of amorphous hydrogenated silicon-carbon p-i-n heterostructures is not completely understood. Experimental analysis combined with comprehensive numerical simulation are the tools used to develop a physical model for the dominant transport mechanism inside

the heterostructures. To achieve unambiguous results it is useful to concentrate on peculiarities of the device, such as the bias voltage dependent spectral response and the current–voltage (I-V) characteristics under different light bias conditions. A series of large area single layers and heterojunction cells in the assembly glass/ZnO:Al/p ( $\text{Si}_x\text{C}_{1-x}\text{:H}$ )/i (Si:H)/n ( $\text{Si}_x\text{C}_{1-x}\text{:H}$ )/Al ( $0 < x < 1$ ) were produced by PE-CVD at low temperature. The structural and optoelectronic properties of the single layers were determined through infrared and visible spectroscopy, temperature-dependent conductivity and complemented by CPM measurements. Junction properties, carrier transport, photogeneration and collection efficiency are investigated from dark and illuminated current-voltage characteristics and spectral response measurements, with and without additional background illumination and under different light bias conditions. The bias voltage dependent spectral response (with and without bias light) and the I-V dependence has been simulated and compared to experimentally obtained values. Results show that in the heterostructures the bias voltage influences the field and the diffusion part of the photocurrent differently. The interchange between primary and secondary photocurrent (i. e. between generator and load device operation) is explained by the interaction of field- and diffusion components within the photocurrent. A field reversal that depends on the light bias conditions (wavelength and intensity) explains the photocurrent reversal. The field reversal leads to the collapse of the diode regime (primary photocurrent) launches surface recombination at the p-i and i-n interfaces leading to a double-injection regime (secondary photocurrent). Considerations about conduction band offsets, electrical field profiles and inversion layers will be taken into account to explain the optical and voltage bias dependence of the spectral response.

**DEPENDENCE OF THE LATERAL PHOTOEFFECT IN a-Si:H p-i-n  
STRUCTURES ON THE MATERIAL CHARACTERISTICS STUDIED  
BY MEANS OF A NUMERICAL SIMULATION**

A. Fantoni; M. Fernandes; M. Vieira

Instituto Superior de Engenharia de Lisboa.

**Publicado em:** *Proceedings of Material Research Society Symposium,  
MRS Conference, S. Francisco, USA, April, 2002.*

When an a-Si:H p-i-n structure is locally illuminated by a light spot, the non uniformity of light causes the appearance of a gradient in the carrier concentration between the illuminated and the dark zone. Carrier start to flow in agreement with such gradients, and when equilibrium is reached, the lateral diffusion process is counterbalanced by the appearance of a lateral component of the electric field vector in addition to the transverse usual one. The lateral fields act as a gate for the lateral flow of the carriers and small lateral currents appears at the transition region between the illuminated and the dark zone. Known as *lateral photo-effect*, this phenomena depends on the incident light wavelength, light intensity and on the applied bias. Anyway, its intensity can be, depending on the foreseen application, alternatively enhanced or reduced by correct device engineering. We have used the 2D numerical simulator ASCA to analyze the behavior of a-Si:H p-i-n structures under local illumination with the goal of observing the appearance of the lateral components of the electric field and current density vectors. The dependence of the lateral potential redistribution on the doping density, density of defects in the intrinsic layer, and layer thickness have been analyzed. This study aims to show how material properties and device geometry can be combined in order to control the lateral photo-effect.

#### RECUPERAÇÃO DE INFORMAÇÃO EM VOIP

Carlos Eduardo de Meneses Ribeiro

Instituto Superior de Engenharia de Lisboa.

**Publicado em:** *Actas da Conferência Científica e Tecnológica de Engenharia, ISEL, Maio, 2002.*

Este artigo compara duas estratégias para recuperação ou disfarce da informação de sinais de fala, de pacotes perdidos em ligações IP. Uma dessas estratégias emprega predição de longa duração, já proposta no apêndice 1 da recomendação G.711 do ITU-T, que data de 1999. É agora proposta outra estratégia, utilizando um preditor de curta duração e entrelaçamento entre amostras, que diminui a probabilidade de perda de amostras consecutivas, embora aumentando a complexidade e atraso. Esta probabilidade é ainda diminuída desde que haja possibilidade de colocar na rede pacotes com prioridades diferentes. Garantindo a chegada ao receptor de amostras suficientemente próximas, pode-se tirar partido

da grande correlação entre amostras consecutivas para extrapolar a informação em falta.

### SENSORES DE IMAGEM BASEADOS EM HETEROESTRUTURAS DE SILÍCIO/CARBONO p-i-n PARA APLICAÇÕES BIOMÉTRICAS

M. Vieira; M. Fernandes; P. Louro; Y. Vygranenko; A. Fantoni; R. Schwarz

Instituto Superior de Engenharia de Lisboa.

**Publicado em:** *Actas da Conferência Científica e Tecnológica de Engenharia, ISEL, Maio, 2002.*

Este trabalho descreve a optimização do sensor de imagem “Laser Scanned Photodiode” LSP, para utilização como leitor biométrico de impressões digitais. Um raio laser ilumina a impressão digital sobre uma superfície de vidro colocada na parte frontal do sensor. A luz reflectida pelo vidro é projectada sobre a superfície activa e a imagem é convertida num sinal eléctrico pelo sensor LSP. Os resultados mostram que é necessário um compromisso entre os parâmetros do sistema de leitura por varrimento e a estrutura utilizada como sensor biométrico, de modo a minimizar a interferência (cross-talk) entre as rugas (regiões escuras) e os vales (zonas claras) da impressão digital. Na configuração optimizada e sob polarização inversa a informação específica de cada impressão digital apresenta um bom contraste, e a resolução espacial é aproximadamente 20  $\mu\text{m}$ . A utilização de polarização inversa proporciona um aumento da sensibilidade claro/escuro, um aumento na gama dinâmica de cerca de duas ordens de grandeza e uma responsividade inferior a 65  $\text{Wcm}^{-2}$ .

### INFLUÊNCIA DA CONDUTIVIDADE DAS PELÍCULAS DOPADAS NA UTILIZAÇÃO DE ESTRUTURAS p-i-n COMO SENSORES DE IMAGEM (LSP)

P. Louro<sup>a</sup>; M. Fernandes<sup>a</sup>; Y. Vygranenko<sup>a</sup>; R. Schwarz<sup>a</sup>; M. Vieira<sup>a</sup>; M. Schubert<sup>b</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>Institut für Physikalische Elektronik, Universität Stuttgart, Germany.

**Publicado em:** *Actas da Conferência Científica e Tecnológica de Engenharia, ISEL, Maio, 2002.*

Neste trabalho utilizaram-se filmes finos amorfos de grande área e estruturas p-i-n do tipo vidro/ZnO:Al/p(Si<sub>x</sub>C<sub>1-x</sub>:H)/i(Si:H)/n(Si<sub>x</sub>C<sub>1-x</sub>:H)/Al (0 < x < 1) produzidos por deposição química por vapor assistida por plasma, a baixa temperatura. Realizou-se um estudo das propriedades das estruturas p-i-n, no que diz respeito ao transporte de portadores de carga e à fotogeração, através das características corrente-tensão e capacidade-tensão, no escuro e sob iluminação. Nas heterojunções, as curvas corrente tensão, sob iluminação, apresentam uma forma em S, o que se traduz por baixos da percentagem de área útil. A medida da resistência série conduziu igualmente a valores elevados, da ordem de 10<sup>5</sup>. Uma simulação numérica permitiu igualmente compreender o mecanismo de transporte das estruturas. Os dados da simulação ajustam-se aos resultados medidos experimentalmente, sugerindo que o mecanismo de transporte no escuro depende essencialmente de deriva enquanto que sob iluminação é controlada principalmente pela difusão de portadores.

#### OPTIMIZAÇÃO DO SISTEMA DE AQUISIÇÃO PARA SENSORES DE IMAGEM LSP

M. Fernandes; M. Vieira; J. Martins; P. Louro; A. Maçarico; R. Schwarz

Instituto Superior de Engenharia de Lisboa.

**Publicado em:** *Actas da Conferência Científica e Tecnológica de Engenharia, ISEL, Maio, 2002.*

Este trabalho propõe melhorar a prestação de sistemas baseados em sensores de imagem de grande área do tipo *Laser Scanned Photodiode* (LSP) através da optimização dos parâmetros de aquisição de sinal, tais como a intensidade e secção do feixe de varrimento, tempo de aquisição e condições de polarização. A resposta do sensor e a relação sinal ruído está relacionada com parâmetros básicos como a intensidade da imagem, intensidade do feixe de varrimento e polarização. Os resultados mostram que a resolução que o sensor pode atingir está directamente relacionada com as características do dispositivo e na prática é limitada pelo tempo de aquisição. O diâmetro do feixe de varrimento limita a resolução devido à sobreposição de zonas claras e escuras, levando a um efeito de esborratamento na imagem final, e a uma conseqüente diminuição da

resolução. A resposta do sensor é limitada pela resistência de carga, que para velocidades de varrimento altas deve ser mantida em valores baixos.

### **SIMULAÇÃO ELECTRÓNICA DE UM SENSOR DE IMAGEM BASEADO EM DISPOSITIVOS p-i-n**

J. Martins; M. Fernandes; M. Vieira

Instituto Superior de Engenharia de Lisboa.

**Publicado em:** *Actas da Conferência Científica e Tecnológica de Engenharia, ISEL, Maio, 2002.*

Um sensor de imagem baseado num dispositivo p-i-n sob iluminação local é modelado por uma estrutura não linear em que o elemento activo do sensor é descrito por uma matriz de duas dimensões de fotodíodos interligados através de resistências laterais. A estrutura do sensor inclui contactos frontais e posteriores utilizados como interface eléctrica. A imagem é constituída por uma luz estacionária projectada numa localização fixa na superfície fotosensível. O processo de aquisição da imagem inclui a medição do valor da fotocorrente induzida por um feixe de luz modulada de pequena intensidade que varre a superfície do sensor. A análise das características de saída do sensor é efectuada com recurso a uma ferramenta de simulação baseada no programa SPICE, através da alteração de alguns parâmetros no circuito a simular. Os resultados obtidos demonstram que a geometria e a localização dos contactos afectam a distorção da imagem recuperada. A condutividade das camadas dopadas e a intensidade do fluxo de luz de iluminação influenciam a resolução e a correcção da imagem. Os resultados de simulação e os resultados experimentais apresentam uma boa concordância.

### **CONFIGURAÇÃO ELÉCTRICA INTERNA DE CÉLULAS SOLARES DE SILÍCIO AMORFO DE TIPO p-i-n: A IMPORTÂNCIA DA CAMADA INTRÍNSECA ESTUDADA ATRAVÉS DE UMA SIMULAÇÃO NUMÉRICA**

A. Fantoni

Instituto Superior de Engenharia de Lisboa.

**Publicado em:** *Actas da Conferência Científica e Tecnológica de Engenharia, ISEL, Maio, 2002.*

Este trabalho propõe-se estudar o comportamento eléctrico interno de células solares de silício amorfo de tipo p-i-n. A importância da camada intrínseca será estudada através do programa de simulação numérica ASCA; parâmetros como a sua espessura e a densidade de defeitos são postos em relação com a distribuição interna do potencial, do campo eléctrico, de portadores de carga eléctrica e da taxa de recombinação em condições de diferente iluminação (luz monocromática, branca, e de diferente intensidade) e de tensão aplicada. As propriedades macroscópicas da célula solar (representadas pela característica corrente-tensão em termos de factor de forma, corrente de circuito fechado, potencial de circuito aberto e eficiência de conversão energética) podem ser relacionadas com as características da camada intrínseca e explicadas através do modelo de transporte tipo difusão-deriva em conjunto com o modelo de recombinação Shokley-Read-Hall. Os resultados apresentados permitem enfatizar as diferentes contribuições das componentes de deriva e de difusão na fotocorrente colectada. Será possível desta maneira estabelecer a configuração óptima da célula, e atingir o máximo rendimento expectável do dispositivo em função da espessura e qualidade da camada intrínseca.

#### PHOTOCONDUCTIVITY STUDIES OF $\text{Al}_{0.18}\text{Ga}_{0.82}\text{N}/\text{GaN}$ SINGLE HETEROSTRUCTURES

M. Niehus<sup>a,b</sup>; S. Koynov<sup>b</sup>; P. Sanguino<sup>b</sup>; M. Heuken<sup>c</sup>; B. K. Meyer<sup>d</sup>; R. Schwarz<sup>a,b</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>Dept. Física, Instituto Superior Técnico, Portugal; <sup>c</sup>AIXTRON, Aachen, Germany; <sup>d</sup>I. Physics, University of Giessen, Germany.

**Publicado em:** *Actas da Conferência Científica e Tecnológica de Engenharia, ISEL, Maio, 2002.*

We present spectral photoconductivity (SPC) and transient photoconductivity (TPC) studies in a  $\text{Al}_{0.18}\text{Ga}_{0.82}\text{N}/\text{GaN}$  single heterostructure. We attribute near bandgap peaks in the SPC between 300 K and 500 K to a deep trap-conduction band transition. The trap distribution lies approximately 100 meV above the valence band edge, for both GaN and AlGaN layer. In TPC studies we show that charge

buildup after strong pulsed laser excitation can be detected by anomalous photocurrent decay.

## TRANSPORT PROPERTIES OF STRONGLY DISORDERED MAGNETIC SEMICONDUCTORS AND THIN MAGNETIC LAYERS

V. K. Dugaev

Instituto Superior de Engenharia de Lisboa.

**Publicado em:** *Actas da Conferência Científica e Tecnológica de Engenharia, ISEL, Maio, 2002.*

We discuss a theory of the low-temperature transport properties of strongly disordered magnetic semiconductors and metallic ferromagnets. Quantum corrections, caused by electron localisation and the electron-electron interaction, control the dependence of the resistivity on temperature and magnetic field. We analyse the localisation-induced charge and spin conductivity, the anomalous Hall effect and their dependence on magnetic doping. The role of the spin-orbit interaction and the effective dimensionality of the structure is discussed.

## SIMULATING INCOMPLETE INFORMATION EXCHANGE AMONG SOFTWARE AGENTS

Paulo T. Silva; Porfírio Filipe

Instituto Superior de Engenharia de Lisboa.

**Publicado em:** *Actas da Conferência Científica e Tecnológica de Engenharia, ISEL, Maio, 2002.*

The paper presents a communication layer, fitted to simulate incomplete information exchange among software agents inhabiting a simulation environment. Communication layer is designed to ensure simulation repeatability at the message exchange level. Message exchange impact on repeatability is found to have some addressable open issues within RoboCup-Rescue simulation environment's present stage. The RoboCup-Rescue simulation environment architectural model is considered. This model considers multiple heterogeneous software agents

and several domain specific aspect simulators. In this model, a set of communicative acts sustains all inter-agent information exchange as well as agent world acting and sensing capabilities. It is assumed that agent's information exchange model, follows a connectionless simple request reply communication pattern. A reliable UDP-based protocol, less resource demanding than TCP, is proposed. Incomplete information exchange is regarded as a nonfunctional facet. Knowledge of the environment communicative acts is introduced at the communication layer, so that application level independency is achieved on that nonfunctional facet. To illustrate usage of the proposed mechanism, RoboCup-Rescue simulation environment is used and the layer presented in this paper plugged into that model. A domain specific aspect simulator supporting run time changeable message corruption rate is depicted.

## O PROJECTO OCTOPUS: O MÓDULO RECONHECEDOR DE ZONAS OXIDADAS

Rodolfo Oliveira<sup>b</sup>; HJ Pinheiro-Pita<sup>a,b</sup>; Fernando Coito<sup>b,c</sup>; A. Steiger-Garção<sup>b,c</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>UNINNOVA – Instituto de Desenvolvimento de Novas Tecnologias; <sup>c</sup>Universidade Nova de Lisboa, Faculdade de Ciências e Tecnologia.

**Publicado em:** *Actas da Conferência Científica e Tecnológica de Engenharia, ISEL, Maio, 2002.*

O projecto OCTOPUS – “Remote Control Maintenance of Ship’s Hull and Topside” foi um projecto Brite-Euram com o n.º BE97-4385, concluído em Agosto de 2001. A parceria foi composta pela empresa francesa Cybernertix (que coordenava), pelas instituições italianas ICO, RGI e pelas instituições portuguesas UNINNOVA e LISNAVE. No presente artigo é apresentado o módulo de reconhecimento de zonas oxidadas, da responsabilidade do UNINNOVA. Na primeira implementação deste módulo a solução passava pela implementação de um classificador baseado no modelo CMYK de cor, recorrendo à Teoria dos Conjuntos Difusos – CLASSFUZ. Embora a solução encontrada desempenhasse com sucesso a sua tarefa na maioria das situações, obrigava à existência de uma biblioteca de conjuntos de distribuição de probabilidade para cada situação específica tinta/oxidação. Neste artigo discute-se uma segunda implementação do classificador baseado numa rede neuronal de perceptrões com retro-propagação. O novo classificador

utiliza informação fornecida pelo classificador baseado em conjuntos difusos – CLASSFUZ. No fim apresenta-se a solução encontrada para a integração deste módulo no sistema OCTOPUS.

## ANÁLISE DE DADOS SOBRE AUDIMETRIA DA TELEVISÃO EM PORTUGAL

Nuno Datia<sup>a</sup>; HJ Pinheiro-Pita<sup>a,b</sup>; Carlos Leandro<sup>a</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>UNINOVA – Instituto de Desenvolvimento de Novas Tecnologias.

**Publicado em:** *Actas da Conferência Científica e Tecnológica de Engenharia, ISEL, Maio, 2002.*

Nos últimos 30 anos tem-se assistido a um rápido desenvolvimento de técnicas de aprendizagem automática, por exemplo, para classificação e para agrupamento (*clustering*). A área do KDD – Descoberta de Conhecimento a partir de Bases de Dados, tem por objectivo a aplicação destas técnicas sobre grandes volumes de informação. Este artigo descreve uma primeira proposta de um sistema capaz de prever as audiências dos quatro canais de televisão portugueses a funcionar em antena aberta. Um sistema com estas características é uma ferramenta importante no suporte à decisão, não só para especialistas em grelhas de televisão, como também para publicitários e anunciantes. Assim, partindo dos dados recolhidos durante dois anos por uma empresa de audimetria a operar em Portugal, contendo registos diários de 1800 indivíduos (minuto a minuto), distribuídos por 600 famílias, representando uma população de 8,9 milhões de telespectadores em 3 milhões de habitações e dos ficheiros contendo as grelhas de programação desses canais, desenvolveu-se o trabalho a seguir apresentado.

## CLASSIFICADOR DE POEMAS

Paulo A. Araújo<sup>a</sup>; Nuno J. Mamede<sup>b</sup>

<sup>a</sup>L2F/Instituto Superior de Engenharia de Lisboa; <sup>b</sup>L2F/Instituto Superior Técnico.

**Publicado em:** *Actas da Conferência Científica e Tecnológica de Engenharia, ISEL, Maio, 2002.*

Descreve-se um classificador para poemas da poética portuguesa. A classificação dos poemas é realizada com base nos conceitos de estrofe, verso, sílaba e rima definidos no dicionário de termos literários e no dicionário de literatura. Foi implementado um conjunto de regras que tem em conta o número de versos por estrofe, o número de sílabas de cada verso e a rima utilizada. O protótipo desenvolvido agrega um módulo que contém o léxico, um módulo que realiza a interface com uma aplicação externa que gera transcrições fonéticas e gera divisões silábicas das palavras, e 3 módulos funcionais. São utilizadas técnicas de processamento da língua natural para realizar a correcção ortográfica do poema, tendo também sido desenvolvidos algoritmos para classificar os poemas. É feita uma avaliação do protótipo descrito, utilizando diferentes tipos de poemas. Por último são apresentadas algumas conclusões relativamente às potencialidades e limitações do classificador descrito.

### SERVIÇOS E AGENTES EM SISTEMAS DE INFORMAÇÃO: UMA PERSPECTIVA INTEGRADORA

L. Morgado; A. Teófilo

Instituto Superior de Engenharia de Lisboa.

**Publicado em:** *Actas da Conferência Científica e Tecnológica de Engenharia, ISEL, Maio, 2002.*

Neste artigo é discutido o interesse das abordagens baseadas em agentes como meio de lidar com a crescente complexidade dos sistemas de informação, bem como a forma como essas abordagens poderão ser integradas com os paradigmas e tecnologias actuais, em particular com as abordagens baseadas em serviços. Nesse sentido, é proposto um modelo de agente que permite essa integração através da definição das capacidades de um agente em termos de serviços disponíveis, sobre os quais o agente pode raciocinar no sentido de atingir os respectivos objectivos.

### POTENCIAÇÃO MODULAR EM ARQUITECTURAS COM EXTENSÕES SIMD

Pedro Félix; João Belo

**Publicado em:** *Actas da Conferência Científica e Tecnológica de Engenharia, ISEL, Maio, 2002.*

Considera-se a optimização da potenciação modular no contexto de operações criptográficas. Trata-se a sua adequação a arquitecturas com extensões SIMD e a organizações *superpipelined*. Identifica-se paralelismo na operação de potenciação modular. Apresentam-se formas de vectorização e paralelização da multiplicação de Montgomery e propõem-se três algoritmos. Avalia-se o desempenho destes no processador *Pentium 4*.

### UMA NOVA ABORDAGEM AO ENSINO INTRODUTÓRIO DA PROGRAMAÇÃO USANDO JAVASCRIPT/HTML

Jorge Martins; Luís Falcão; Pedro Félix; Pedro Pereira

Instituto Superior de Engenharia de Lisboa.

**Publicado em:** *Actas da Conferência Científica e Tecnológica de Engenharia, ISEL, Maio, 2002.*

Apresenta-se nesta comunicação uma nova abordagem no ensino introdutório da programação, usando a linguagem JavaScript no contexto de documentos HTML. Tem-se por objectivo melhorar o rendimento do processo de ensino/aprendizagem, aumentando a motivação dos alunos e reduzindo a complexidade marginal, introduzida pelas linguagens classicamente usadas para este efeito. Elencam-se os temas abordados, indicando a ênfase e exemplos utilizados. Compara-se a abordagem adoptada com outras existentes, nomeadamente as baseadas na utilização da linguagem Java.

### DETECTOR DE RADAR NA BANDA X

Henrique Silva; Fernando Fortes

Instituto Superior de Engenharia de Lisboa.

**Publicado em:** *Actas da Conferência Científica e Tecnológica de Engenharia, ISEL, Maio, 2002.*

Esta comunicação descreve o enquadramento, projecto, implementação e teste dum sistema de detecção de Radares Marítimos a operar na banda X. Trata-se dum trabalho multidisciplinar, pois envolve o estudo de antenas impressas, electrónica de microondas, electrónica analógica e electrónica digital de processamento. Referem-se os bons resultados práticos e mostra-se ser possível a obtenção dum detector compacto, leve, de muito baixo custo de produção e baixo consumo.

### SINCRONIZAÇÃO BASEADA NO MODELO DA DINÂMICA EMISSOR-RECEPTOR EM COMUNICAÇÃO MÓVEL

Fernando M. G. Sousa<sup>a</sup>; José M. N. Leitão<sup>b</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>Instituto Superior Técnico.

**Publicado em:** *Actas da Conferência Científica e Tecnológica de Engenharia, ISEL, Maio, 2002.*

Neste trabalho trata-se o problema da sincronização de portadora em cenários de comunicação rádio móvel onde, devido ao movimento relativo emissor-receptor, há variação significativa de fase durante o intervalo de símbolo. Formula-se a comunicação digital como problema de estimação recursiva, bayesiana, em canal afectado por ruído aditivo, branco, gaussiano. A variação de fase, devida ao movimento relativo, é modelada por um processo de Gauss-Markov de terceira ordem. A detecção símbolo a símbolo e o seguimento da fase, durante o intervalo de símbolo, são realizados por um banco de filtros estocásticos não-lineares e um algoritmo de decisão baseado no critério de máxima probabilidade *a posteriori*. Apresentam-se resultados de simulação, em cenários realistas, evidenciando a relevância dos algoritmos e da abordagem adoptada.

### SEGUIMENTO DO CORPO HUMANO COM MODELOS ARTICULADOS BIDIMENSIONAIS

Rui M. Jesus<sup>a</sup>; Arnaldo J. Abrantes<sup>a</sup>; Jorge S. Marques<sup>b</sup>

**Publicado em:** *Actas da Conferência Científica e Tecnológica de Engenharia, ISEL, Maio, 2002.*

Este trabalho tem como objectivo o seguimento dos movimentos de um corpo humano observado por uma câmara de vídeo. O seguimento do corpo humano é uma tarefa complexa devido à oclusão temporária de alguns segmentos do corpo durante o movimento, e à dificuldade em detectar com precisão pontos anatómicos na imagem sem usar marcas artificiais. Este artigo descreve um algoritmo de seguimento que evita a utilização destas marcas. O método proposto é baseado em três modelos: um modelo geométrico do corpo humano, um modelo de movimento que descreve a evolução dos parâmetros do modelo geométrico, e um modelo da aparência visual de cada segmento do corpo humano. O sistema proposto tem capacidade de aprender a partir de experiências anteriores e de melhorar o seu desempenho durante a operação de seguimento. Para ilustrar o desempenho do sistema de seguimento são apresentados resultados experimentais.

#### APOIO AO DIAGNÓSTICO MÉDICO BASEADO EM REDES BAYESIANAS

Isabel Milho<sup>a</sup>; Ana Fred<sup>b</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>Instituto Superior Técnico.

**Publicado em:** *Actas da Conferência Científica e Tecnológica de Engenharia, ISEL, Maio, 2002.*

O trabalho apresentado nesta comunicação consiste numa ferramenta para desenvolvimento de aplicações de diagnóstico médico, baseada em redes bayesianas. O sistema de apoio tem interface adequada ao desenho de aplicações de diagnóstico por especialistas do domínio clínico, sem que estes tenham conhecimentos profundos da teoria das redes bayesianas. Depois de desenhada a aplicação específica, a interacção com o especialista é feita via página de Internet (utilização habitual da aplicação). Considerando que a maioria dos modelos de diagnóstico médico tem uma estrutura simples, composta por relações causais doença-sintoma, o mecanismo de inferência implementado tira partido da estrutura do modelo simplificado, aliviando a complexidade

computacional. Apresenta-se um exemplo de aplicação para diagnóstico na área das doenças do sono, ilustrando a funcionalidade do sistema.

### ESTIMAÇÃO DE VELOCIDADE DE ALVOS MÓVEIS EM RADAR DE ABERTURA SINTÉTICA USANDO DADOS SUB-AMOSTRADOS

Paulo Marques<sup>a</sup>; José Dias<sup>b</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>Instituto Superior Técnico.

**Publicado em:** *Actas da Conferência Científica e Tecnológica de Engenharia, ISEL, Maio, 2002.*

Apresenta-se uma estratégia inovadora para obtenção de estimativas de velocidade radial de alvos móveis cujas velocidades induzem deslocamentos em frequência superiores ao limite de Nyquist imposto pela frequência de repetição de impulso (*Pulse Repetition Frequency – PRF*). Usa-se o facto de o deslocamento em frequência na direcção de tempo-lento ser linearmente dependente da velocidade radial para cada frequência em tempo-rápido. Assim, o espectro bidimensional do eco proveniente dum alvo móvel exhibe um declive que depende da velocidade radial do objecto e que não está limitada pelo PRF. A metodologia proposta é avaliada usando dados simulados e dados reais.

### BIOMETRIC SYSTEM BASED ON ONE SINGLE LARGE AREA a-SiC:H p-i-n PHOTODIODE

M. Vieira; M. Fernandes; A. Fantoni; P. Louro

Instituto Superior de Engenharia de Lisboa.

**Publicado em:** *Proceedings of 1st IEEE International Conference on Sensors, Hyatt, Orlando, Kissimmee, Florida, USA, June, 2002.*

Based on the Laser Scanned Photodiode (LSP) image sensor we present an optical fingerprint reader for biometric authentication. The device configuration and the scanning system are optimized for this specific purpose. The scanning technique for fingerprint acquisition is improved and the effects of the probe beam size, wavelength and flux, the scan

frequency on image contrast and resolution will be analyzed under different electrical bias. An optical model of the image acquisition process is presented and supported by a two dimensional simulation. Results show that a trade-off between read-out parameters (fingerprint scanner) and the biometric sensing element structure (p-i-n structure) are needed to minimize the cross talk between the fingerprint ridges and the fingerprint valleys. In the heterostructures with wide band gap/low conductivity doped layers the user-specific information is detected with a good contrast while the resolution of the sensor is around 20  $\mu\text{m}$ . A further increase in the contrast is achieved by slightly reverse biasing the sensor with a sensitivity of  $6.5 \text{ Wcm}^{-2}$  and a flux range of two orders of magnitude.

### INFLUENCE OF THE INTRINSIC LAYER CHARACTERISTICS ON a-Si:H p-i-n SOLAR CELL PERFORMANCE ANALYSED BY MEANS OF A COMPUTER SIMULATION

Alessandro Fantoni<sup>a,b</sup>; Manuela Vieira<sup>a</sup>; Rodrigo Martins<sup>b</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>FCT-UNL, Monte de Caparica, Portugal.

**Publicado em:** *Solar Energy Materials and Solar Cells*, vol. 73(2), pp. 151-162, Elsevier Science BV, Amsterdam, IDS Number: 558RE, ISSN: 0927-0248, June, 2002.

In this paper a set of one-dimensional simulations of a-Si:H p-i-n junctions under different illumination conditions and with different intrinsic layer are presented. The simulation program ASCA permits the analysis of the internal electrical behaviour of the cell allowing a comparison among the different internal configurations determined by a change in the input set. Results about the internal electric configuration will be presented and discussed outlining their influence on the current tension characteristic curve. Considerations about the drift-diffusion and the generation-recombination balance distributions, outlined by the simulation, can be used to explain the correlation between the basic device output, the i-layer characteristics (thickness and DOS), the incident radiation intensity and photon energy.

## FERROMAGNETISM IN DILUTED MAGNETIC SEMICONDUCTORS AT LOW CARRIER DENSITY

V. K. Dugaev<sup>a,b</sup>; V. I. Litvinov<sup>b</sup>; J. Barnás<sup>c</sup>; A. H. Slobodskyy<sup>d</sup>; W. Dobrowolski<sup>e</sup>; M. Vieira<sup>a</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>WaveBand Corporation, Torrance, USA; <sup>c</sup>Dept. of Physics, Adam Mickiewicz University, Poland and Inst. of Molecular Physics, Polish Acad. of Sciences, Poland; <sup>d</sup>Physikalisches Institut, Würzburg, Germany; <sup>e</sup>Inst. of Physics, Polish Acad. of Sciences, Poland.

**Publicado em:** *Proceedings of the European Conference on Physics of Magnetism, Poznan, Poland, July, 2002.*

We present a general approach to the problem of a ferromagnetic phase transition in diluted magnetic semiconductors with free carriers. The Curie temperature of ferromagnetic transition is calculated in the mean field approximation. The approach allows to analyze the effects of magnetic fluctuations and disorder on the Curie temperature. We also propose a new mechanism of exchange interaction between magnetic impurities at vanishing concentration of free carriers.

## VELOCITY ESTIMATION OF FAST MOVING TARGETS USING UNDERSAMPLED SAR RAW-DATA

Paulo Marques<sup>a</sup>; José Dias<sup>b</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>Instituto Superior Técnico.

**Publicado em:** *European Conference on Synthetic Aperture Radar, EUSAR 2002, Cologne, Germany, July.*

It is well known that a moving target induces a Doppler-shift and a Doppler-spread on the returned signal in the slow-time frequency domain. Most of the techniques proposed in recent literature take advantage of this knowledge to retrieve the moving target image and velocity parameters. The azimuth velocity of a moving target is the responsible for the spread in the slow-time frequency domain whereas the range velocity induces the Doppler-shift. Given a PRF, the Doppler-shift is confined to,  $-\text{PRF}/2 < f_D < \text{PRF}/2$ , where  $f_D = 2v_r/\lambda$  is the azimuth Doppler-shift induced by a moving target with range velocity  $v_r$ , when the carrier wavelength is  $\lambda$ . If the signal is aliased (the induced Doppler-shift exceeds PRF/2) it has been generally accepted that the true

moving target range velocity cannot be uniquely determined using a single antenna and a single pulse scheduling. The traditional solution to resolve such targets consists in increasing the PRF, or alternatively, in using a non-uniform PRF. The increasing of the PRF leads to a decrease in the maximum unambiguous range swath, besides the huge memory requirements to store the received signal. The use of a non-uniform PRF needs a non-conventional pulse scheduling. Moreover, non-uniform sampling introduces higher complexity in image reconstruction. Using typical SAR mission parameters, a single sensor, and uniform pulse scheduling, we readily conclude that the maximum unambiguous range velocity is usually very small. The approach herein proposed to estimate the range velocity of moving targets with velocities above the maximum imposed by the PRF is based on the knowledge that the Doppler-shift in the azimuth spectra depends linearly on the radar fast-time frequency; i.e., the Doppler-shift varies with the wavenumber  $k = 2 /$  proportionally to the true target range velocity. In the two dimensional frequency domain, a moving target return will exhibit a slope which is not subject to PRF limitations. We will present a methodology to retrieve the linear dependence of the Doppler-shift in the azimuth dimension with the fast-time frequency, thus computing an unaliased estimate of the moving target range velocity. The developed methodology is not intended to achieve high accuracy on the range velocity estimation. Rather, it is designed to retrieve the azimuth spectral support where the Doppler-shift belongs. This information is crucial to retrieve the range velocity with high accuracy. Experimental results using real data from the MSTAR public release data set will be presented.

## INCOMPLETE INFORMATION EXCHANGE IN A SIMULATION ENVIRONMENT: A COMMUNICATION LAYER APPROACH

Paulo T. Silva<sup>a</sup>; Porfírio Filipe<sup>a</sup>; Helder Coelho<sup>b</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>Faculdade de Ciências da Universidade de Lisboa, Departamento de Informática, Bloco C5, Piso 1, Campo Grande, 1749-016 Lisboa, Portugal.

**Publicado em:** *First International Joint Conference on Autonomous Agents and Multi-Agent Systems – AAMAS. Workshop on Regulated Agent Based Social Systems: Theories and Applications – RASTA, Bologna, Italy, July, 2002.*

The paper presents a communication layer, fitted to simulate incomplete information exchange among software agents inhabiting a simulation environment. The communication layer is designed to ensure simulation repeatability at the message exchange level. Message exchange impact on repeatability is found to have some addressable open issues within RoboCup-Rescue simulation environment's present stage. The RoboCup-Rescue simulation environment architectural model is considered. This model considers multiple heterogeneous software agents and several domain specific aspect simulators. In this model, a set of communicative acts sustains all inter-agent information exchange as well as agent-world acting and sensing capabilities. RoboCup-Rescue communicative acts are classified from the simulation repeatability perspective. It is assumed that agent's information exchange model, follows a connectionless simple request-reply communication pattern. A reliable UDP-based protocol, less resource demanding than TCP, is proposed. Incomplete information exchange is regarded as a nonfunctional facet. Knowledge of the environment communicative acts is introduced at the communication layer, so that application level independency is achieved on that nonfunctional facet. The paper describes the experiments and presents the results that validate the proposal of an UDP based reliable protocol. The RoboCup Rescue simulation environment is used to materialize and analyze the proposed classification of communicative acts.

#### TUNING THE SPECTRAL DISTRIBUTION OF p-i-n a-SiC:H DEVICES FOR COLOUR DETECTION

M. Vieira; P. Louro; A. Fantoni; M. Fernandes

Instituto Superior de Engenharia de Lisboa.

**Publicado em:** *Proceedings of Eurosensors XVI, European Conference on Solid-state Transducers, Praga, Czech Republic, September, 2002, in press.*

ZnO:Al/p (SiC:H)/i (Si:H)/n (SiC:H) large area image and colour transducers are analysed. Carrier transport and collection efficiency are investigated from dark and illuminated current-voltage dependence and spectral response measurements under different optical and electrical bias conditions. Results show that the carrier collection depends on the optical

bias and on the applied voltage. By changing the electrical bias around the open circuit voltage it is possible to filter the absorption at a given wavelength and so to tune the spectral sensitivity of the device. Transport and optical modelling give insight into the internal physical process and explain the bias control of the spectral response and the image and colour sensing properties of the devices.

## NEW COLOUR AND IMAGE LASER SCANNED PHOTODIODE SENSOR

M. Fernandes; M. Vieira; P. Louro; A. Fantoni; J. Martins

Instituto Superior de Engenharia de Lisboa.

**Publicado em:** *Proceedings of Eurosensors XVI, European Conference on Solid-state Transducers, Praga, Czech Republic, September, 2002, in press.*

Large area p-i-n a-SiC:H heterostructures are used as LSP color sensors. For reading out the RGB color signals three forward appropriate voltages close to the open circuit conditions have to be successively applied in order to combine information to yield a color image. The high resistive SiC doped layers confine the photogenerated carriers at the different generation regions and driven by the scanner extract information on the image color and intensity. As the applied bias increases the reversed electrical field in the bulk shifts and successively suppresses the ac component of the photocurrent at each primary color allowing color extraction.

## A MOBILE AGENTS APPROACH TO VIRTUAL LABORATORIES AND REMOTE SUPERVISION

L. M. Camarinha-Matos<sup>a</sup>; Octavio Castolo<sup>a</sup>; Walter Vieira<sup>b,a</sup>

<sup>a</sup>New University of Lisbon, Faculty of Sciences and Technology, Quinta da Torre, 2829-516 Monte Caparica, Portugal; <sup>b</sup>Instituto Superior de Engenharia de Lisboa, DEETC, Portugal.

**Publicado em:** *Journal of Intelligent and Robotic Systems, vol. 35, pp. 1-22, issue 1, September, 2002.*

This paper presents the use of adaptive mobile agents for remote operation, enabling real-time response in spite of the limitations of the communication channels in terms of time-delays, availability, and reliability. Autonomy of the mobile agents is achieved through high levels of intelligence including execution monitoring and error recovery. Potential applications range from traditional telerobotics to virtual laboratories where mobile agents act as representatives of users in scientific experiments. Practical results are presented in a scenario where a SCARA-type robot is remotely commanded through the Internet.

### ADAPTIVE CARRIER TRACKING IN MOBILE COMMUNICATION AN INNOVATIONS-BASED APPROACH

Fernando M. G. Sousa<sup>a</sup>; José M. N. Leitão<sup>b</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>Instituto Superior Técnico.

**Publicado em:** *Proceedings of the IEEE VTS 56th Vehicular Technology Conference, VTC 2002–Fall, vol. 4, pp. 2273-2277, Vancouver, September, 2002.*

In this paper we address the problem of mobile communication with highly accelerative emitter/receiver dynamics. Additive white Gaussian noise channel is assumed, and the relative motion is modelled as a vector Gauss-Markov process, from which only the first component is observed. The receiver consists of a bank of stochastic nonlinear filters and a decision algorithm driven by the filters innovations processes. In practice, to cope with any real trajectory, specially with maneuvers, an adaptive strategy has to be adopted. In the solution herein presented, the receiver commutes between two models (double integrated Brownian motions with different variance parameters), switching being determined by the symbol decision metrics, which is based on the filters innovations processes. This adaptive receiver has good carrier tracking capability with the corresponding performance in terms of bit error probability.

### TRACKING THE HUMAN BODY USING MULTIPLE PREDICTORS

Rui M. Jesus<sup>a</sup>; Arnaldo J. Abrantes<sup>a</sup>; Jorge S. Marques<sup>b</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>Instituto de Sistemas e Robótica, Instituto Superior Técnico.

**Publicado em:** *Second International Workshop on Articulated Motion and Deformable Objects, International Association for Pattern Recognition (IAPR), Palma de Maiorca, November, 2002.*

The objective of this work is to track the human body from a video sequence, assuming that the motion direction is parallel to the image plane. Tracking the human body is a difficult task because the human body may have unpredictable movements and it is difficult to accurately detect anatomic points in images without using artificial marks. Furthermore, self-occlusions often prevent the observation of some body segments. This paper describes a tracking algorithm, which avoids the use of artificial marks. The proposed system is able to learn from previous experience, and therefore its performance improves during the tracking operation. The ability of the tracking system to gradually adapt to a particular type of human motion is obtained by using on-line learning methods based on multi-predictors. These predictors are updated in a supervised way using information provided by a human operator. Typically, the human operator corrects the model estimates several times during the first few seconds, but the corrections rate decreases as time goes by. Experimental results are presented in the paper to illustrate the performance of the proposed tracking system.

#### EFFECTS OF MISMATCH ON CMOS MONOLITHIC MIXERS IMAGE REJECTION

Fernando Azevedo<sup>a,b</sup>; M. João Rosário<sup>b,c</sup>; J. Costa Freire<sup>b,c</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>Instituto de Telecomunicações; <sup>c</sup>Instituto Superior Técnico.

**Publicado em:** *The 13<sup>th</sup> IEEE International Symposium on Personal Indoor and Mobile Radio Communications, vol. 5, pp. 2372-2376, Lisbon, September, 2002.*

For current PCS systems to have low cost terminals, the IC technology must be standard CMOS. One very important key-part in transceiver design that allows eliminating the off-chip discrete components, to fully integration, is the mixer. In the last few years some authors proposed several architecture solutions where one of them stands out, the wide-band intermediate frequency double conversion system. The wide-band

intermediate frequency (IF) architecture converts all the radio frequency (RF) spectrum passing through the input RF filter directly to base band (BB) as in the case of direct conversion. No band pass filtering is performed at IF. However in contrast to direct conversion, the translation takes place in two steps, using two local oscillators (LO) and two sets of mixers. This provides the following main advantages: no oscillator operates at the RF input frequency, and the tuning of the receiver can be accomplished using the second low frequency LO. The double balanced mixer presented in this publication is an image rejection converter that uses six single mixers to implement the above referred architecture. Each single mixer is implemented with CMOS Gilbert cells. If the branches I (in-phase) and Q (quadrature) are perfectly matched and the local oscillators are applied in quadrature the image is fully rejected on both I and Q outputs. Cancellation of AM LO noise and spurious responses, and port to port isolation is also obtained with this topology. Finally, circuit simulation results are developed and applied to the design of a monolithic CMOS mixer for wireless applications.

#### A DISTRIBUTED WEB-BASED K-12 MANAGEMENT SYSTEM

João Ferreira<sup>a</sup>; Alberto Silva<sup>b</sup>; Rui Azevedo<sup>b</sup>; Gonçalo Borrêga<sup>b</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>Instituto Superior Técnico; INESC-ID.

**Publicado em:** *E-Learn 2002, ISSN 1-880094-46-0, pp. 1455-1458, Association for the advancement of Computing in education (AACE), Montreal, Canada, October, 2002.*

The project “Rent@School – Bringing the Future to the Education” is a research effort to study and prototype information system architectures to support, standardize, and facilitate the management of K12 schools at a national scale. It looks for the sharing and dissemination of relevant information among different stakeholders, based on the ASP model and also on a novel architecture, which we called “distributed and multi-instance web architecture”. This architecture means that beyond the existence of a unique central/national Rent@School instance, multiple Rent@School instances can be installed at local/regional scale, in a way that autonomy, performance and flexibility of all the system can be improved. This issue is introduced and discussed in this paper from two complementary perspectives: from the organizational and management

information systems perspective; and from the integration and large-scale interoperability.

## UNDERSTANDING FOR ENHANCING CMOS MONOLITHIC IMAGE REJECTION MIXERS

Fernando Azevedo<sup>a,b</sup>; M. João Rosário<sup>b,c</sup>; J. Costa Freire<sup>b,c</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>Instituto de Telecomunicações; <sup>c</sup>Instituto Superior Técnico.

**Publicado em:** *Asia-Pacific Microwave Conference-APMC, vol. 2, pp. 675-678, Kyoto, Japan, November, 2002.*

The growing needs for low power and low cost wireless mobile transceivers, have motivated researchers to study and present new monolithic solutions implemented in standard CMOS technology. Image rejection ratio in double balanced mixers is strongly dependent on the balance between its branches. The influence of the mismatches is analyzed theoretically at the system and circuit level. Guidelines to obtain a given image rejection ratio based on a deep calculation of the related maximum acceptable mismatch are presented, allowing to meet a given IRR specification. A practical circuit implementation is described: a 1.9 GHz downconversion image rejection mixer is fabricated in 0.6  $\mu$ m CMOS standard technology. Measurements on this prototype showed a 34 dB image rejection and an overall conversion gain of 16 dB. Finally, experimental results are presented.

## ANALOG READOUT IMAGE SENSOR BASED ON p-i-n HYDROGENATED AMORPHOUS SILICON

M. Vieira<sup>a</sup>; M. Fernandes<sup>a</sup>; P. Louro<sup>a</sup>; J. Martins<sup>a</sup>; A. Maçarico<sup>a</sup>; R. Schwarz<sup>a</sup>; M. Schubert<sup>b</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>Institut für Physikalische Elektronik, Universität Stuttgart, Germany.

**Publicado em:** *Vacuum, vol. 64, pp. 249-254, IDS Number: 510HH, ISSN: 0042-207X, Elsevier Science LTD, Oxford, 2002.*

Amorphous glass/ZnO:Al/p(a-Si:H)/i(a-Si:H)/n(a-Si<sub>1-x</sub>C<sub>x</sub>:H)/Al imagers with different n-layer resistivities were produced by Plasma Enhanced Chemical Vapour Deposition technique (PE-CVD). The image is projected onto the active surface of the sensor and defines itself spatially confined depletion regions that can be readout by scanning the photodiode with a low power modulated laser beam. The essence of the scheme is the analogue readout, and the absence of semiconductor arrays or electrode potential manipulations to transfer the information coming from the transducer. The effect of the image intensity on the sensor output characteristics (sensitivity, linearity, blooming, resolution, and signal-to-noise ratio) are analysed for different material composition ( $0.5 < x < 1$ ). The results show that the responsivity and the spatial resolution are limited by the conductivity of the doped layers. An enhancement of 75 % in the image resolution is achieved with responsivity of 0.2 mW/cm<sup>2</sup> decreasing the n-layer conductivity by one order of magnitude. An analysis of the image acquisition and representation is performed. A physical model supported by an electrical simulation gave insight into the methodology used for image representation.

**c-Si/a-Si:H HETEROJUNCTION WITH INTRINSIC THIN LAYER SOLAR CELLS: A SIMULATION ANALYSIS ABOUT THE J-V CHARACTERISTIC DEPENDENCE ON THE INTERFACE BAND OFFSETS**

A. Fantoni<sup>a,b</sup>; Y. Vygranenko<sup>a</sup>; M. Fernandes<sup>a</sup>; R. Schwarz<sup>a</sup>; M. Vieira<sup>a</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>FCT-UNL, Portugal.

**Publicado em:** *Vacuum*, vol. 65, Elsevier Science LTD, Oxford, 2002.

Recent studies on amorphous-crystalline silicon p-i-n heterojunctions (HIT, Heterojunction with Intrinsic Thin layer) have indicated the potential for these materials to be used as low cost, high efficiency solar cells. Moreover the HIT structure is also expected to be suitably applied to various semiconductor junctions for micro and optoelectronic devices. Despite this potential, the exact operation of these cells is not yet fully understood and a S-shaped J-V characteristic curve is observed under certain conditions, leading to a poor collection efficiency. We present in this paper some results, obtained using the computer simulator ASCA,

about the internal electric configuration of a p a-Si:H /a-Si:H / n c-Si heterostructure under different illumination conditions. The obtained results are related to the corresponding simulated J-V characteristic curve and compared with our experimental results, in order to explain the S-shaped J-V curve featured by these devices. The band discontinuities at the amorphous-crystalline interface are shown to be responsible for such a behavior. We find that the conduction band offset is the most limiting parameter for the optimal collection of photogenerated carriers.

### ENERGY RELAXATION DURING INELASTIC ELECTRON SCATTERING ON LOCALIZED STATES

V. K. Dugaev<sup>a,b</sup>; V. L. Volkov<sup>b</sup>; M. Oszwaldowski<sup>c</sup>; M. Vieira<sup>a</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>Chernovtsy Branch, Institute for Problems in Materials Science, National Academy of Sciences of Ukraine, Ukraine; <sup>c</sup>Technical University, Poznan, Poland.

**Publicado em:** *Technical Physics Letters*, vol. 28(11), pp. 904-906, American Institute of Physics, Melville, IDS Number: 617LC, ISSN: 1063-7850, 2002.

A mechanism which can be responsible for the phase relaxation in polycrystalline semiconductors and metals is proposed. This mechanism is related to the inelastic scattering of electrons on localized states with energies near the Fermi level.

### BIAS CONTROLLED SPECTRAL SENSITIVITY IN a-SiC:H p-i-n DEVICES

P. Louro; A. Fantoni; M. Fernandes; Y. Vygranenko; R. Schwarz; M. Vieira

Instituto Superior de Engenharia de Lisboa.

**Publicado em:** *Physics E*, in press.

Large area p-i-n a-SiC:H heterojunctions with low conductivity and wide band gap doped layers were produced by PE-CVD at low temperature (100 °C). Carrier transport and collection efficiency are investigated from dark and illuminated current-voltage dependence and spectral response measurements under different optical bias conditions (430 nm, 530 nm

and 650 nm,  $0 < L < 1015$  ph/s). Results show that is possible to control the absorption at a given wavelength and so to tune the spectral sensitivity by changing the electrical bias ( 0.3 V) around the open circuit voltage. The spectral response at different voltages with and without optical bias and the photocurrent-voltage dependence has been simulated and compared to experimentally obtained values. Results show that for each wavelength a specific electrical bias creates a space charge at the main absorption region causing a reversal of the electric field that hinders carrier collection at this wavelength. The field reversal leads to the collapse of the diode regime (primary photocurrent), launches surface recombination at the interfaces, which leads to a double-injection regime (secondary photocurrent). The interchange between primary and secondary photocurrent is explained by the interaction of drift and diffusion components within the photocurrent. Considerations about conduction and valence band offsets, electrical field profiles and inversion layers will be taken into account to explain the bias control of the spectral response.

#### NON-PIXELED AMORPHOUS SILICON BASED IMAGE SENSORS

M. Fernandes; J. Martins; Y. Vygranenko; M. Vieira

Instituto Superior de Engenharia de Lisboa.

**Publicado em:** *Physics E, in press.*

Large area hydrogenated amorphous silicon p-i-n structures with low conductivity doped layers were proposed as single element monochrome image sensors. The investigation of the sensor output under different scanner wavelengths and varying electrical bias reveals that the response can be tuned to a certain wavelength, thus enabling color separation. The measurement technique is described in detail and two methods for color separation are proposed. The sensor output characteristics are evaluated under different bias voltages and wavelengths. The color separation mechanism can be explained by the variation of the band bending with light wavelength. The operation of the sensor is exemplified under illumination with a polychromatic image and using one of the proposed detection methods.

## OPTICAL PROPERTIES AND TRANSPORT IN PLD-GaN

M. Niehus<sup>a</sup>; P. Sanguino<sup>a</sup>; T. Monteiro<sup>b</sup>; MJ Soares<sup>b</sup>; E. Pereira<sup>b</sup>; M. Vieira<sup>c</sup>; S. Koynov<sup>c</sup>; R. Schwarz<sup>c</sup>

<sup>a</sup>IST, Dept Phys, Lisboa, Portugal; <sup>b</sup>Universidade de Aveiro, Dept Phys, P-3810193 Aveiro, Portugal; <sup>c</sup>Instituto Superior de Engenharia de Lisboa; <sup>d</sup>Bulgarian Acad Sci, CL SENES, Sofia 1784, Bulgária.

**Publicado em:** *Solid-State Electronics*, vol. 47(3), pp. 569-573, Elsevier Science LTD, Oxford, IDS Number: 641RG, ISSN: 0038-1101, March, 2003.

We present structural, optical and transport data on GaN samples grown by hybrid, two-step low temperature pulsed laser deposition. The band gap of samples with good crystallinity has been deduced from optical spectra. Large below gap band tails were observed. In samples with the lowest crystalline quality the PL spectra are quite dependent on spot laser incidence. The most intense PL lines can be attributed to excitons bounded to stacking faults. When the crystalline quality of the samples is increased the ubiquitous yellow emission band can be detected following a quenching process described by a similar activation energy to that one found in MOCVD grown samples. The samples with the highest quality present, besides the yellow band, show a large near band edge emission which peaked at 3.47 eV and could be observed up to room temperature. The large width of the NBE is attributed to effect of a wide distribution of band tail states on the excitons. Photoconductivity data supports this interpretation.

## A NEW MECHANISM OF EXCHANGE INTERACTION IN FERROMAGNETIC SEMICONDUCTORS

V. K. Dugaev<sup>a,b</sup>; V. I. Litvinov<sup>c</sup>; J. Barnás<sup>d</sup>; M. Vieira<sup>a</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>Inst. For Problems of Materials Science, Nat. Acad. Sci. of Ukraine, Ukraine; <sup>c</sup>WaveBand Corporation, Torrance, USA; <sup>d</sup>Dept. of Physics, Adam Mickiewicz University, Poland and Inst. of Molecular Physics, Polish Acad. of Sciences, Poland.

**Publicado em:** *Physical Review Letters*, in press.

We propose a new mechanism of indirect exchange interaction, which can be responsible for the ferromagnetic ordering in Mn-doped semiconductors (like GaMnAs) at low carrier concentration. The mechanism is based on the interplay of the hybridization of band states

with localized impurity states and the direct exchange interaction between localised spins and band states. The indirect exchange coupling between two impurities occurs when the wave functions of the corresponding localized donor (acceptor) states overlap. This coupling is independent of the free carrier concentration and therefore may be responsible for ferromagnetic transition at low or vanishing carrier concentrations.

## FERROMAGNETIC ORDERING IN DILUTED MAGNETIC SEMICONDUCTORS

A. H. Slobodosky<sup>a,b,c</sup>; V. K. Dugaev<sup>a,d</sup>; M. Vieira<sup>d</sup>

<sup>a</sup>Inst. For Problems of Materials Science, Nat. Acad. Sci. of Ukraine, Ukraine; <sup>b</sup>Inst. Of Physics, Polish Acad. of Sciences, Poland; <sup>c</sup>Physikalisches Institut, Wurzburg, Germany; <sup>d</sup>Instituto Superior de Engenharia de Lisboa.

**Publicado em:** *Condensed Matter Physics*, vol. 5, n.º 3(31), pp. 531-540, 2002.

We present a general approach to the problem of a ferromagnetic phase transition in diluted magnetic semiconductors. The Curie temperature of ferromagnetic transition is calculated in the mean field approximation. It is shown that the Curie temperature is determined by an integrated coupling between magnetic impurities.

## FERROMAGNETIC ORDERING IN DILUTED MAGNETIC SEMICONDUCTORS

V. K. Dugaev<sup>a,b</sup>; Y. Vygranenko<sup>c</sup>; M. Vieira<sup>a</sup>; V. I. Litvinov<sup>d</sup>; J. Barnás<sup>e</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>Inst. For Problems of Materials Science, Nat. Acad. Sci. of Ukraine, Ukraine; <sup>c</sup>Dept. of Electrical and Computer Engineering, University, Waterloo, Canada; <sup>d</sup>WaveBand Corporation, Torrance, USA; <sup>e</sup>Dept. of Physics, Adam Mickiewicz University, Poland and Inst. Of Molecular Physics, Polish Acad. of Sciences, Poland.

**Publicado em:** *Physica E*, in press.

We present a theoretical analysis and results of modelling of a new integrated device for spintronics applications, which is based on a hybrid metal-semiconductor structure. The proposed device consists of a Si-

based p-i-n photodetector sandwiched between two layers of a ferromagnetic metal. Electron-hole pairs are created in the semiconductor part of the structure by light illumination. The photocurrent flowing in such a system is shown to depend on its magnetic configuration. This is due to a difference in the specular reflection of spin-up and spin-down electrons and holes from magnetically polarized layers. This, in turn, allows controlling the device performance by an externally applied magnetic field. We have estimated magnitude of the effect and also determined the role of relevant material parameters.

## FERROMAGNETISM IN DILUTED MAGNETIC SEMICONDUCTORS AT LOW CARRIER DENSITY

V. K. Dugaev<sup>a,b</sup>; V. I. Litvinov<sup>b</sup>; J. Barnás<sup>c</sup>; A. H. Slobodskyy<sup>d</sup>; W. Dobrowolski<sup>e</sup>; M. Vieira<sup>a</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>WaveBand Corporation, Torrance, USA; <sup>c</sup>Dept. of Physics, Adam Mickiewicz University, Poland and Inst. of Molecular Physics, Polish Acad. of Sciences, Poland; <sup>d</sup>Physikalisches Institut, Würzburg, Germany; <sup>e</sup>Inst. Of Physics, Polish Acad. of Sciences, Poland.

**Publicado em:** *Phys. Stat. Sol., in press.*

We present a general approach to the problem of a ferromagnetic phase transition in diluted magnetic semiconductors with free carriers. The Curie temperature of ferromagnetic transition is calculated in the mean field approximation. The approach allows to analyze the effects of magnetic fluctuations and disorder on the Curie temperature. We also propose a new mechanism of exchange interaction between magnetic impurities at vanishing concentration of free carriers.

## FERROMAGNETISM IN DILUTED MAGNETIC SEMICONDUCTORS AT LOW CARRIER DENSITY

V. K. Dugaev<sup>a,b</sup>; V. I. Litvinov<sup>b</sup>; J. Barnás<sup>c</sup>; A. H. Slobodskyy<sup>d</sup>; W. Dobrowolski<sup>e</sup>; M. Vieira<sup>a</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>WaveBand Corporation, Torrance, USA; <sup>c</sup>Dept. of Physics, Adam Mickiewicz University, Poland and Inst. Of Molecular Physics, Polish Acad. of Sciences, Poland; <sup>d</sup>Physikalisches Institut, Würzburg, Germany; <sup>e</sup>Inst. Of Physics, Polish Acad. of Sciences, Poland.

**Publicado em:** *Journal of Superconductivity, in press.*

We analyse critical temperature of ferromagnetic ordering in diluted magnetic semiconductors in the mean field approximation. Using a general field-theoretical approach we formulate a description of magnetic phase transition, which takes into account the interaction of magnetic fluctuations. We also propose a mechanism of exchange interaction between Mn impurity moments in GaMn As alloys via the Mn-induced acceptor levels. This mechanism may lead to low temperature ferromagnetism at vanishing concentration of free carriers.

#### a-Si:H THIN FILM TANDEM SOLAR CELL PHYSICS EXPLAINED BY MEANS OF NUMERICAL SIMULATION

Alessandro Fantoni<sup>a,b</sup>; Manuela Vieira<sup>a</sup>; Reinhard Schwarz<sup>a,c</sup>

<sup>a</sup>Instituto Superior de Engenharia de Lisboa; <sup>b</sup>CEMOP-UNINOVA, <sup>c</sup>Instituto Superior Técnico.

**Publicado em:** *Proceedings of the 17<sup>th</sup> World Photovoltaic Energy Conference and Exhibition, 2002, in press.*

Stacked a-Si:H pin/pin diodes are known to be more stable with respect to the light induced degradation than the conventional single junction pin structure. This can be ascribed to a better internal electric field distribution leading to an improved drift transport mechanism within the intrinsic layers. However the device performance can be limited by the reverted field associated with the internal n-p interface region (recombination junction). Such a different built-in field configuration leads to a device functioning fundamentally different from the standard p-i-n device, which can be well described through a detailed analysis of the internal electrical configuration of the device. Without questioning the consideration that the multi-junction structure needs component cells of high efficiency and that high quality layers of both intrinsic and doped materials are necessary, we understand that optimised device design also can be used successfully to improve cell performance. Bandgap profiling, as well the introduction of buffer layers between the doped and intrinsic layers, can improve the built-in field within the cell, aiding carrier transport. We have studied, as an application of the numerical simulator ASCA, the internal electrical configuration of the pin/pin structure (homo and hetero-junctions) under illumination (monochromatic and AM1.5 spectrum) and under forward applied bias. Aiming to produce a good understanding of the device physics and a general orientation for device

engineering, this paper discusses the influence of material properties (optical gap extension, conductivity, defect density, doping concentration) and of device geometry (layer thickness, recombination junction area) on the final device performance, by relating the internal distribution of charged carriers, recombination rate and potential profile to the J-V characteristic.

## A NEW LSP SENSOR FOR IMAGE RECOGNITION AND COLOUR SEPARATION

M. Vieira; M. Fernandes; P. Louro; A. Fantoni

Instituto Superior de Engenharia de Lisboa.

**Publicado em:** *Proceedings of E-MRS 2002, European Material Research Society, in press.*

Studies on the use SiC:H p-i-n devices as Laser Scanned Photodiode (LSP) monochrome image sensors have shown its potential capability. In this work, the fact that the variation of the photocurrent with the voltage strongly depends upon the wavelength provides the LSP with its intrinsic wavelength filtering properties allowing color separation. Large area sensing elements are produced by PE-CVD at low temperature (100 °C). The i-layer is thick enough (>500 nm) to absorb all the light incoming from the image. For reading out the color signals (red, green and blue), three forward appropriated voltages around the open circuit conditions ( $\pm 0.3$  V) have to be successively applied in order to combine information to yield a color image. The high resistive and wide band gap doped layers confine the photogenerated carriers at the illuminated regions and driven by the scanner extract information on the image range and intensity. The forward bias controls the absorption and the electric field across the main generation region. As the applied bias increases the reversed electrical field in the bulk shifts and successively suppress the ac component of the photocurrent at each primary color allowing color extraction. The device performance is analyzed and the scanning technique for color separation improved. The effects of the bias on image contrast; resolution and color separation are discussed. A physical model for image and color recognition is presented and supported by a two dimensional simulation.