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PHOTOLUMINESCENCE AND FTIR ABSORPTION STUDY ON POROUS Si AGING PHENOMENA

Porous silicon photoluminescence (PL) stability is of great importance as it limits light-emitting device application. The study of correlations between PL and infrared absorption (FTIR) spectra is necessary in order to fully understand the chemical compound-related aging phenomena in porous Si. PL and FTIR spectra on as-prepared, stored in air and oxidized samples have been measured. A gradual replacement of hydrogen terminated surface with that of oxygen terminated for aged in air and intentionally oxidized samples have been compared. In contrary to the degradation of the PL from aged in air samples, the enhancement of the PL intensity under Ar^+ laser beam excitation from oxidized in H_20_2 at room temperature porous layers was observed. We conclude that the oxidation of the SiH_x bonds in the latter case prevents from the formation of nonradiative centers on the surface. Additionally, the oxidation of the Si skeleton reduces the size of the Si "crystallites" which are too large to participate in the light emission in as-anodized porous layer.

Materiał zaprezentowano na sesji posterów.

MATERIALS RESEARCH SOCIETY SPRING MEETING
San Francisco, CA, USA, 2-9/04. 1994

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MATHEMATICAL FORMULATION OF CONSTITUTIONAL SUPERSATURATION CRITERION IN CRYSTAL GROWTH FROM VAPOUR

Mathematical formulation of the constitutional supersaturation criterion in vapour transport crystal growth at high temperatures is presented. The novel formula is deduced from relation between concentrated distribution of the crystal forming component above the growth interface and temperature distribution in the crystal at the interface [1,2]. It was found, that if the rate of surface processes is infinite and radiative heat transfer between the furnace and growth interface dominates, then constitutional supersaturation exists according to formula $G(4\sigma L\varepsilon\Delta Tp)/(R^2k)$, where G is gradient of concentration of the crystal forming component at interface, σ is Stefan-Boltzmann constant, L is latent heat of sublimation, ε is average emissivity of the growing surface, ΔT is difference between the effective average temperature of the elements (furnace, ampoule) “seen” by the crystallization front and average temperature of the crystallization front, p is pressure of the saturated vapour at the interface, R is the gas constant and k is crystal heat conductivity.

[1] K.Grasza, J.Crystal Growth 128 (1993) 609,

[2] K.Grasza and A.Jędrzejczak, J.Crystal Growth, submitted.

WORKSHOP: COST OPTICAL TELECOMUNICATIONS FIBRES AND COMPONENTS FOR SYSTEM APPLICATIONS: PRESENT AND FUTURE, Nice, France, 17-19/04. 1994

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OPERATION OF WAVEGUIDE RING LASER WITH NONLINEAR OUTCOUPLER

The waveguide ring lasers have attracted attention because of the elimination of the need for high quality mirrors and possibility of the integration with the optic waveguide systems. Especially, the waveguide ring lasers with the nonlinear outcoupler, because of the possible bistable operation which can find their applications in high-speed communication systems as well as optical and data processing. In this paper the time-dependent output light intensity is analyzed for the nonlienar outcoupler with instantaneous and finite response time. The region of the stable and bistable laser operation is investigated as a function of the system parameters. It is shown that the ratio of the saturation intensity of the gain medium to the saturation intensity of the nonlinear outcoupler play an important role in obtaining bistable operation with histeresis loop. The presented analysis also allows to optimize the stable waveguide ring laser radiation

Materiał zaprezentowano na sesji posterów.

EXMATEC '94 - 2nd INTERNATIONAL WORKSHOP ON EXPERT EVALUATION AND CONTROL OF COMPOUND SEMICONDUCTOR MATERIALS AND TECHNOLOGIES
Parma, Italy 18-20/05. 1994

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DEEP LEVELS IN RAPID THERMAL ANNEALED GaAs

Rapid thermal annealing (RTA) is widely used to anneal out implantation damage and activate implanted dopants in III-V compound semiconductors. In the RTA process, the temperature of semiconductor wafers drops sharply from ~900 °C at a rate of 100 - 200 deg/s after the radiation is switched off. The main advantage of this technology in fabricating of MESFETs, compared to conventional furnace annealing, is that it results in minimized dopant and background impurity diffusion during annealing. However, because of the fast quenching, the point defects generated at the high temperature can be frozen and affect the material electrical characteristics. So, the aim of this work is to find the effect of the RTA temperature on the behaviour and concentration of deep-level defects in the Si-doped n-type GaAs with an electron concentration similar to that of active layer of MESFETs.

Deep level transient spectroscopy (DLTS) measurements were carried out on Cr/Au-GaAs Schottky barrier structures using both the non-annealed (reference) GaAs wafers and the wafers after RTA at different high temperatures of 650, 700, 750, 800, 850 and 900 °C. The annealing period was 35 s. Before the RTA treatment, the SiO_2 cap layer with a thickness of 1500 Å was sputtered on to the polished surface of GaAs wafers.

In the wafers annealed at 650 - 800 °C the EL2 concentration was found to be ~ 1.5×10^{16} cm^{-3} and comparable to that as before the RTA treatment. Annealing at 850 °C and 900 °C resulted in a significant drop of the EL2 concentration to ~5×10^{15} cm^{-3}. This fact suggests that during this treatment one third of arsenic antisites As_{Ga} brakes into As_i and V_{Ga}. Simultaneously, a change in the EL2 activation energy was observed from E_c - 0.73 eV, for the reference wafers and that treated at the temperatures up to 800 °C, to E_c - 0.66 eV and E_c - 0.59 eV for wafers annealed at 850 °C and 900 °C, respectively. This change is probably due to a thermal stress resulting from the temperature gradient across the wafer during annealing. Apart from EL2, an 0.44-eV electron trap was observed both in the reference and annealed wafers. It was found that the maximum concentration of this trap (~ 1.3×10^{15} cm^{-3}) occurs after RTA process at 650 and 700 °C. In the reference wafer as well as in the wafers annealed at 850 °C and 900 °C the concentration of this trap was in the order of a magnitude lower. An electron trap at E_c - 0.42 eV was induced by the RTA process. The concentration of this trap was found to vary with the RTA temperature reaching maximum ~ 5×10^{14} cm^{-3} in the wafers treated at 800 °C. The results obtained indicate that RTA temperature should be optimized in order to control the properties and concentration of deep-level defects in active layers of MESFETs.

Materiał zaprezentowano na sesji wykładów zaproszonych.

NATO ADVANCED REASERCH WORKSHOP ON MCM-C/MIXED TECHNOLOGIES, Islamorada, Florida, USA, 23-25/05. 1994

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PHOTOSENSITIVE THICK FILMS PROSPECTS FOR APPLICATION TO SILICON SOLAR CELLS

Photosensitive thick film materials may have a great influence on improvement of nterconnection technologies to provide higher density solutions, in the near future. They provide designers with a possibility to introduce into microcircuits very narrow conductive paths (well below 50 μm) and dielectric layer with very well defined vias This has a great impact on thick film multilayer structures.

Photoimageable paste is applied onto substrate by conventional screen printing procedure. However, the paste contains photosensitive organic vehicle that enables to combine thick film technology with photolithography. After drying, the pastes are exposed to UV light through the appropriate photomask to form a desired image. Following the exposure, a developing process is required. The developed layer is fired in standard thick film procedure.

Some application examples will be presented. Advantages and disadvantages of applying photoimageable thick film technology will be discussed as well.

The results of work on photosensitive materials done at two different research sights located in Lwow (Ukraine) and Warsaw (Poland) will be presented Links of their cooperation will be also shown.

Materiał zaprezentowano na sesji posterów.
Pełny tekst drukowany będzie w materiałach z konferencji.

FOURTH SEEHEIM WORKSHOP ON MÖSSBAUER SPECTROSCOPY, Seeheim, Germany 24-28/05.1994

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PHASE TRANSFORMATIONS IN N-IMPLANTED α-Fe

The recently performed systematic Mössbauer study of nitride-phase formation in iron implanted with nitrogen ions allowed us to propose the implantation dose-anneal temperature "phase diagram" for N-implanted α-Fe [1]. This diagram resulted from the detailed CEMS investigations performed for α-Fe samples implanted at room temperature with 100 keV N_2^+ ions whose mean range in the iron target was about 55 nm. The implantation dose varied from 5×10^{16} to 6×10^{17} N/cm^2. After implantation each sample was annealed in vacuum for 1 h at temperatures from 150 to 550°C in 50°C steps. Each annealing step was followed by CEMS measuremens. The CEMS measurements allowed identification of the iron nitride phases formed by nitrogen implantation and their transformations due to annealing. It was found that the nitride phases formed are directly related to the amount of nitrogen in the implanted layer. The phase transformations in the course of annealing are related to the nitrogen release due to diffusion.

Our "phase diagram" revealed that the ε-Fe_3N- type and γ'-Fe_4N phases coexist at temperatures above 250°C for N-doses up to 3×10^{17} N/cm^2 and above 300°C for higher nitrogen doses. Also other studies showed that the γ' phase can be produced only during high temperature implantation or after annealing at T>300°C [2,3]. The $\varepsilon \rightarrow \gamma'$ transformation is a relatively slow process and 1 h anneals at 300 - 350°C might be too short to complete it. We have studied the $\varepsilon \rightarrow \gamma'$ transformation as a function of the annealing time at temperatures of 300, 350 and 400°C for α-Fe implanted with the nitrogen dose of 4×10^{17} N/cm^2. At 400°C the $\varepsilon \rightarrow \gamma'$ transformation is completed already after 1 h and the next 1 h anneal causes rapid decomposition of γ' to α-Fe. At 350°C the annealing time of about 10 h is required to complete the transformation of the α phase to the γ' phase, and about 20 h of annealing is necessary to decompose γ' phase to α-Fe. At 300°C the ε → γ' transformation is much slower and takes about 15 h, while even 41 h annealing is not long enough to decompose γ' phase completely. The activation energies for ε → γ' and γ' → α transformations of 0.84 eV and 1.33 eV, respectively, were estimated from the decomposition rate determined by CEMS.

[1] Kopcewicz M., et al., J. Appl. Phys. 71, 1992, 4217

[2] Vredenberg A., et al., J. Mat. Res. 7, 1993, 2689

[3] Wei R., et al., J. Tribology 113, 1991, 166

Materiał zaprezentowano na sesji posterów.

FOURTH SEEHEIM WORKSHOP ON MÖSSBAUER SPECTROSCOPY, Seeheim, Germany 24-28/05. 1994

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MÖSSBAUER STUDIES OF $Fe_{73.5}Cu_1Nb_3Si_{13.5}B_9$ IN DIFFERENT STAGES OF ANNEALING WITH AND WITHOUT APPLIED MAGNETIC RADIO FREQUENCY FIELDS

We produced nanocrystalline and microcrystalline $Fe_{73.5}Cu_1Nb_3Si_{13.5}B_9$ samples by annealing amorphous ribbons in the temperature range from 350°C to 750°C. Varying the heat treatment produces not only different crystalline stages but also samples with different magnetic properties. If the sample is nanocrystalline (annealing at about 550°C for 1 h) the magnetostriction is very low and also excellent soft magnetic properties appear (maximum permeability in the range of 10^5 and very small coercitivities of about 0.01 A/cm). Annealing at higher temperatures (above 625°C) causes the increase of the grain size and the appearance of Fe-B phases. According to the change in the crystalline state the soft magnetic properties deteriorate (coercitivities bigger than 10 A/cm, permeability smaller than 1000).

We used a series of samples covering the whole range from the amorphous, nano- and microcrystalline state and performed Mössbauer measurements in transmission geometry with and without applying a magnetic radio frequency field of about 20 Oe at 68 MHz in plane of the absorber. Mössbauer spectra collected without applying a radio frequency field are normally evaluated for phase identification. The only information regarding to the magnetic properties is a preferred orientation of the magnetization leading to a line intensity ratio of 3:4:1 already without applying an external static magnetic field in plane of the absorber that is observed in the nanocrystalline state. Further information is possible if the sample is e.g. heated in an oven. The hyperfine splittings observed in the spectra then change due to different magnetization curves of the various phases in the sample.

If one applies a magnetic radio frequency field to these samples the shape of the spectra changes significantly because of the rf sideband and the collapse effect. Since the collapse is sensitive to the local magnetic anisotropy of the sample, the sideband intensities show simultaneously information about the magnetostriction of the sample. Applying an rf magnetic field in plane of the absorber seems to enrich the information about FeCuNbSiB according to the interesting magnetic properties.

Materiał zaprezentowano na sesji posterów.