HL 14: Si/Ge

Time: Monday 16:00–17:30 Location: H14

HL 14.1 Mon 16:00 H14

Defect band formation at grain boundaries in laser-crystallized polycrystalline SiGe thin films — •M. Weizman[1], L.-P. Scheller[1], N. H. Nickel[1], and B. Yan[2] — [1]Hahn-Meitner-Institut Berlin, Kekuléstr. 5, 12489 Berlin, Germany — [2]United Solar Ovonic Corporation 1100 West Maple Road Troy, MI 48084, USA

Polycrystalline silicon-germanium (poly-SiGe) alloys are considered as a promising material for thin film solar cells due to their enhanced optical absorption in comparison to poly-Si. The SiGe thin films investigated in this study were fabricated on glass substrates by the following steps. Initially, amorphous silicon-germanium films (a-$Si_{1-x}Ge_x$:H) were deposited by glow-discharge decomposition of a mixture of disilane, germane, and hydrogen to a thickness of 100 to 255 nm. The Ge content, x, of the resulting samples was varied over the entire range $0 < x < 1$. At the second processing step, the amorphous samples were crystallized employing a XeCl excimer laser. Electron spin resonance (ESR) measurements done on these samples at low temperatures ($5 < T < 60$ K) reveal that at a critical Ge content of about $x = 0.5$ the ESR signal vanishes completely for the Ge rich alloys and instead a broad signal caused by electron cyclotron resonance (ECR) appears. This result is interpreted as the formation of a defect band at the grain boundaries at a critical dangling bound defect density which is in the range of $5 \cdot 10^{18}$ cm^{-3}. Angle resolved measurements of the ECR signal as well as conductivity measurements are also presented in order to support this hypothesis.

HL 14.2 Mon 16:15 H14

Structural and electronic properties of ultra-thin polycrystalline Si layers on glass substrates — Tobias Antesberger, •Christian Jaeger, Michael Scholz, and Martin Stutzmann — Walter Schottky Institut, Am Coulombwall 3, 85748 Garching, Germany

Polycrystalline silicon thin films on glass substrates are attractive for large area electronics and solar cell applications. A promising method to obtain large-grained high quality polycrystalline films by re-crystallization of an amorphous precursor material is the aluminum-induced layer exchange (ALILE). Here, an Al/amorphous Si layer stack, separated by a thin oxide film, is annealed at temperatures up to the eutectic temperature of 577 °C, leading to an exchange of the positions of the initial layers and the crystallization of the amorphous Si. We have studied the structural properties of ultra-thin polycrystalline layers (10 nm - 100 nm) prepared with ALILE by means of X-ray diffraction measurements and Raman spectroscopy, providing evidence of a good crystalline quality. The electronic properties investigated by conductivity and Hall effect measurements show a decreasing carrier density and an increasing mobility with increasing layer thickness. Hydrogen passivation leads to partially depleted layers due to compensation caused by surface states. This effect is investigated by electron spin resonance and spin-dependent transport.

HL 14.3 Mon 16:30 H14

Study of the disproportionation in bulk amorphous germanium monoxide — •Andreas Schacht[1], Christian Sternemann[1], Achim Hohl[2], Henning Sternemann[1], Michael Paulus[1], and Metin Tolan[1] — [1]Dept. Phys. / DELTA, University of Dortmund, D-44221 Dortmund — [2]Institute for Materials Science, Darmstadt University of Technology, D-64287 Darmstadt

Measurements of the x-ray absorption near-edge structure at the Ge K-edge of ex-situ annealed amorphous germanium monoxide samples, i.e. GeO_x ($x \approx 1$), were accomplished in partial fluorescence yield mode at BL9 of the synchrotron radiation source DELTA utilising a spectrometer in Rowland geometry. A systematic temperature dependence was observed for the near-edge structure within the first 10 eV above the Ge K-edge and could be related to the disproportionation process of amorphous germanium monoxide into germanium and germanium dioxide. The onset of the observed disproportionation process was estimated to a temperature of $245 \pm 25°$ C. Full disproportionation into germanium and germanium dioxide was observed at an annealing temperature of $525 \pm 50°$ C. Also crystallisation of samples sets in for temperatures above 525° C which could be confirmed by x-ray diffraction.

HL 14.4 Mon 16:45 H14

Metallic conduction in undoped laser-crystallized polycrystalline silicon-germanium thin films — •L.-P. Scheller[1], M. Weizman[1], N. H. Nickel[1], and B. Yan[2] — [1]Hahn-Meitner-Institut Berlin, Kekuléstr. 5, 12489 Berlin, Germany — [2]United Solar Ovonic Corporation, 1100 West Maple Road Troy, MI 48084, USA

Due to its enhanced optical absorption in the IR and visible spectral range polycrystalline silicon-germanium (poly-SiGe) could become a promising new absorber material for future thin film and tandem solar cells.

The poly-SiGe samples investigated in this study were fabricated in the following way. First, amorphous undoped SiGe (a-SiGe:H) films with a germanium content between 33% and 100% were deposited on quartz substrates. Then, these a-SiGe:H samples were laser-crystallized with a pulsed XeCl excimer laser both by a step-by-step process and by a single laser pulse. Carrier transport in these samples was investigated by Hall and conductivity measurements in a temperature range of 20 K to 300 K.

Although the amorphous base material is undoped, many samples show p-type conduction with astonishing high conductivities in the range of 0.1 to 10 $(\Omega\text{cm})^{-1}$. In addition, the Ge-rich samples exhibit metallic behavior with nearly constant conductivity down to 20 K. Further, a subsequent remote hydrogen plasma treatment leads to a pronounced decrease in conductivity. This surprising behavior is explained in terms of carrier transport in a defect band induced by dangling bond defects at the grain boundaries.

HL 14.5 Mon 17:00 H14

Low-temperature molecular beam epitaxy on polycrystalline Si and Ge seed layers — •Michael Scholz[1], Yuelong Huang[2], Sebastian Gatz[1], Andreas Lambertz[2], Friedhelm Finger[2], Reinhard Carius[2], and Martin Stutzmann[1] — [1]Walter Schottky Institut, Am Coulombwall 3, Technische Universität München, 85748 Garching Germany — [2]Institut fuer Photovoltaik, Forschungszentrum Jülich, Leo-Brandt-Straße,

An interesting approach for low-temperature preparation of polycrystalline silicon-germanium (poly-SiGe) layers with promising structural and electrical properties on non-crystalline substrates is the aluminum-induced layer exchange (ALILE). Here, a bilayer structure of amorphous Silicon-Germanium (a-SiGe) and Aluminum is deposited e.g. on a glass substrate and heated to temperatures below the eutectic temperature of the ternary Al-Si-Ge alloy system (420°C). If they are separated by a thin oxide, the two layers exchange their respective positions and a coherent poly-SiGe film is formed. The Aluminum layer can be used as back contact in a seed layer concept for photovoltaic devices, provided that low-temperature epitaxial overgrowth of the seed layer can be achieved.

To this end, we have studied the epitaxial growth of Si, SiGe and Ge using both very high frequency plasma enhanced chemical vapor deposition (VHF-PECVD) and electron-beam evaporation. The structural and optical properties will be discussed and results from a first photovoltaic device will be presented.

HL 14.6 Mon 17:15 H14

Functional Spin-Coated Nanocrystalline Silicon Layers on Plastic Substrates — •Robert Lechner[1], Roland Dietmüller[1], Andre R. Stegner[1], Rui N. Pereira[1], Martin S. Brandt[1], André Ebbers[2], Frank-Martin Petrat[2], Martin Trocha[2], Hartmut Wiggers[3], and Martin Stutzmann[2] — [1]Walter Schottky Institut, Technische Universität München, Am Coulombwall 3, 85748 Garching — [2]Degussa AG, Paul-Baumann-Str. 1, 45764 Marl — [3]Universität Duisburg-Essen, Institut für Verbrennung und Gasdynamik, Lotharstr. 1, 47048 Duisburg

Semiconducting silicon nanoparticles are possible candidates for various applications in the field of printable electronics and for low cost solar cells. Its natural abundance and non-toxicity make silicon the favorable choice out of a large variety of nanoparticle materials which in principle enable high carrier mobility and stability under atmospheric conditions.

Here, we present results obtained by pulsed laser annealing of spin-coated silicon nanoparticle dispersions on flexible plastic substrates. These nanoparticles are successfully doped during their formation in

a microwave reactor by the addition of diborane and phosphine to the precursor gases. The structural properties of the films before and after the laser treatment are discussed and the conductivity is found to increase by several orders of magnitude. Furthermore, spectrally resolved photoconductivity allows a detailed analysis of electronic transport in spin-on nanoparticular silicon films. In addition, device concepts based on these films will be discussed.