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Report:

In the following we present results about Si/Ge-nanocrystal samples, selectively grown under the following conditions. Si was evaporated by means of an electron beam and deposited on 6*H*-SiC(0001) at a substrate temperatures of 600°C (sample A: Si, growth rate 5 ML/min). Ge was deposited on a carbon-rich 6*H*-SiC(0001) surface from effusion cells at a substrate temperature of 470°C, but with different growth rates (sample C: Ge, 0.8 ML/min, sample D: Ge, 4 ML/min). Additionally, one sample was grown on a Si-rich 6*H*-SiC(0001) surface by depositing Ge at 300°C and subsequent annealing at 800°C for 2 minutes (sample B: Ge, annealed). The x-ray diffractograms ($\theta/2\theta$-scans) of sample A (Si-nanocrystals: average width is 200 nm, average height is 45 nm) showed the occurrence of 111- and 220-reflections at the respective bulk positions. This observation reveals unambiguously that the Si-nanocrystals grow preferentially in two different orientations <111> and <110> with respect to the surface normal. Considering the multiplicities and the structure factor, the peak areas can be used to calculate the ratio between <111>- and <110>-nanocrystals. Such a calculation results 70% <111>- and 30% <110>-nanocrystals for sample A. A similar behavior has been found for Ge-nanocrystals grown with growth rates above 3 ML/min (sample D: 84% <111>- and 16% <110>-nanocrystals). However, by using Ge growth rate below 1 ML/min, the diffractograms showed that we were able to grow (111)-nanocrystals selectively (sample C). Interestingly, for Ge-nanocrystals grown on Si-rich SiC-surfaces (sample B), we observe that the Ge-reflections are shifted towards the angular position of the corresponding Si-reflection. Using Vegards law, it is possible to calculate the average composition of the nanocrystals from the peak shift (60% Si for sample B).

The lateral orientation of the (111)-nanocrystals was investigated using skew reflections (surface normal inclined with respect to the scattering plane). ϕ-scans of skew 220-reflection of the (111)-nanocrystals around the surface normal reveal that the projection of the nanocrystal *a*-axis onto the surface plane is parallel to the $[10\bar{1}0]$-direction of the substrate. This observation shows clearly that the <111>-nanocrystals grow coherently with respect to the substrate. Note, that the skew $10\bar{1}4$-reflection of 6*H*-SiC(0001) was used as a reference to determine the position of the *a*-axis of the substrate. It should be mentioned here that a similar behavior was found for the <110>-nanocrystals. Furthermore, the six-fold symmetry of the ϕ-scans shows clearly the existence of rotation twins. Since the FWHM of the ϕ-scan reflects the degree of coherence between nanocrystals and substrate, our data reveal that the correlation between the Si-nanocrystals and SiC (FWHM = 0.8°) is much better than the correlation between Ge-nanocrystals (sample C: FWHM = 10°) and SiC. Moreover, the Ge-nanocrystals grown at "high flux" conditions (sample D: growth rate 4 ML/min, FWHM > 20°) grow almost incoherent to the substrate. Obviously, the Ge-nanocrystals avoid the stress and strain due to the larger lattice mismatch compared with Si by a poor alignment to the substrate. The ϕ-scan of sample B (Si/Ge alloy, FWHM = 5°) shows that the alignment might be improved by increasing the amount of Si within the Ge-nanocrystal.