Deposition of Ag on the (3×3)- and ($\sqrt{3}\times\sqrt{3}$)R30°-surfaces of 4H-SiC(0001)

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Schottky diodes represent an important perspective for technological application of the compound semiconductor material SiC. However, for SiC the quality of the devices is impaired by large inhomogeneities in the Schottky barriers. The atomic structure of the metal-semiconductor interface clearly determines the properties of the Schottky barrier and therefore seems to be *one* key for improvements. The formation of the interface is strongly affected by the initial stages of metal interaction on the semiconductor surface, which for silicon carbide is largely unexplored. In the present study we investigate the deposition and reaction of Ag on the ($\sqrt{3}\times\sqrt{3}$)R30° and (3×3) surface reconstructions of 4H-SiC(0001), using scanning tunneling microscopy (STM), Auger electron spectroscopy (AES) and quantitative low-energy electron diffraction (LEED). The silver immediately reacts upon deposition as revealed by STM and LEED. The equivalent to 1 monolayer (ML) coverage deposited at room temperature results in total disordering of both original reconstructions. A (1×1) LEED pattern develops after annealing the samples, to 600 °C in the case of the initial ($\sqrt{3}\times\sqrt{3}$)R30° surface, and 500 °C in the case of the (3×3) phase. Consistently, the Ag layer starts to desorb at these temperatures as determined by AES. At smaller Ag coverages (0.15 - 0.4 ML) the surface displays the same behaviour except that the amount of metal is not enough for total disordering, resulting in a reduction of the superstructure spots in the LEED patterns. Real space images (STM) show that the initial deposition of Ag on the (3×3) surface produces small islands which in some cases develop a (3×3) periodicity, also. Annealing to about 500-650 °C (accompanied by a Ag depletion) results in the development of two-dimensional islands leading to a two-level (3×3) structure. Bias dependent STM images and a step height analysis indicate that the lower as well as the upper terrace possess the original (3×3) reconstruction of the clean Si enriched SiC surface. Ag is not incorporated in the ordered patches. This is also corroborated by the LEED intensity spectra being very similar to the clean (3×3) case. In contrast, for Ag deposited on the ($\sqrt{3}\times\sqrt{3}$)R30° phase the fractional LEED spots intensities immediately change after deposition and vanish upon even slight annealing, indicating structural changes in the reconstructed patches. The (1×1) LEED pattern observed at higher coverages is stable during further annealing. Only at 900 °C the original ($\sqrt{3}\times\sqrt{3}$)R30° structure reappears on the sample, whilst in the (3×3) case the (1×1) LEED pattern converts into a (6×6) phase which has been reported also in the temperature induced transition of the clean (3×3) to the ($\sqrt{3}\times\sqrt{3}$)R30° phase and finally transforms to the ($\sqrt{3}\times\sqrt{3}$)R30° phase.