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Epitaxy of CdS on highly mismatched Al2O3 substrates

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Hex-SiGe is a promising material for the photonic integration of data communication, as its direct bandgap allows for silicon-based optoelectronic interconnects. However, hex-SiGe is synthesised in core-shell nanowire structures that are not suitable for future scalability and probing of fundamental properties is difficult due to their small size. To overcome these challenges, it is proposed to grow planar hex-SiGe on wurtzite CdS substrates epitaxially. However, wurtzite CdS substrates are small and expensive. Therefore, investigating the heteroepitaxy of CdS on another substrate becomes worthwhile.

In this research, heteroepitaxial growth of monocrystalline CdS films on highly mismatched (1-102) Al2O3 substrates via molecular beam epitaxy is achieved and the effects of the growth temperature and VI/II ratio are investigated. Characterisation of the CdS film surface morphology, roughness, thickness and crystalline structure is performed. All CdS films exhibit mostly a (0001) oriented crystal structure, which is unsuitable for the epitaxial growth of planar hex-SiGe. However, an improved crystal structure in the CdS film is obtained by increasing the sulfur flux, as observed with rocking curves. Pole figure analysis of the samples grown at a VI/II ratio of 4 indicates the formation of two distinct (0001) oriented CdS domains on the (1-102) Al2O3 substrate. In addition, SAED patterns and cross-sectional BF-TEM images reveal the epitaxial relationships of the (0001) oriented CdS domains on the (1-102) Al2O3 substrate. The achievement and understanding of the heteroepitaxial growth of monocrystalline CdS films on (1-102) Al2O3 will serve as an important basis for future research into this material system.

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