Formation of n-Type $\beta$-FeSi$_2$/p-Type Si Heterojunctions by Facing-Targets Direct-Current Sputtering

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Semiconducting iron disilicide ($\beta$-FeSi$_2$) possessing a direct band gap of 0.85 eV and a large absorption coefficient of $10^5$ cm$^{-1}$ at 1.5 eV is a new promising material for infrared photodiodes. In order to fabricate the heterojunction with Si, the diffusion of Fe atoms from the $\beta$-FeSi$_2$ layer into the Si substrate should be suppressed because the Fe atoms form trap centers in the Si. Epitaxial as-growth of $\beta$-FeSi$_2$ films at a low substrate-temperature is preferable. In this study, $\beta$-FeSi$_2$ thin films were epitaxially grown on Si(111) substrates at a substrate-temperature of 600 °C by facing-targets direct-current sputtering (FTDCS) without post-annealing at high temperatures. The $\beta$-FeSi$_2$ thin film exhibited a smooth surface with few pinholes and a sharp interface with the Si substrate. It was confirmed that the $\beta$-FeSi$_2$ film is epitaxially grown on Si(111) by the XRD measurements. The n-type $\beta$-FeSi$_2$/p-type Si heterojunction showed a typical rectifying action with a rectification ratio of more than two orders of magnitude at bias voltages between ± 1 V at room temperature.