Fabrication of β-$FeSi_2$ by vapor deposition of iron

Tadashi Kawanishi

Abstract

In optical fiber communication systems, photodiodes (PD's) play the important role as devices to convert the optical signal into electrical signal, deciding the system performance. InGaAs/InP PD's are commonly used in the systems with 1.3/1.55-μm wavelength resions. Silicon avalanche photodiodes (APD's) are known as ideal APD's, having lower noise with lower cost than InGaAs/InP APD's. However, silicon has no sensibility to 1.3/1.55-μm bands, because of its bandgap energy. In this study, we fabricate β-$FeSi_2$ (beta iron silicide) by Fe vapor deposition for a PD material with narrow band gap. We also fabricate Ge/Fe/Si heterojunctions to realize APD's for the optical communication systems.

A β-$FeSi_2$ layer was successfully fabricated on a Si wafer by Fe vapor deposition and post-annealing at a temperature of 900 °C under a low-pressure hydrogen atmosphere about 50 Pa. The β-$FeSi_2$ layer was confirmed with RBS and Raman spectra. The directional I-V characteristics were observed but photocurrents were not. The reason is that the β-$FeSi_2$ layer was too thin to raise photocurrents. It is needed to fabricate thicker layer using the other methods.

Ge/Fe/Si heterojunctions were also successfully fabricated using a wafer bonding method. The I-V characteristics were not so good that reverse currents were large, however, photocurrents by a 1.55-μm-band lightwave were observed. The dark currents were quite large and the photocurrents relatively small, and so it is needed to improve dark currents and quantum efficiencies to realize Ge/Fe/Si heterojunction PD's.