パネル上の機能系のための効果的な結晶化によるSiおよびInSb薄膜の電気的特性に関する研究

Form 3

Abstract

Title

Research on the Electrical Properties of Si and InSb Thin Films by Effective Crystallization for Functional System on Panel

Effective crystallization process to realize advance multifunctional next generation System on Panel (SoP) which can integrate Si photosensors or/and InSb magnetic sensors with Thin Film Transistors (TFT) was investigated.

Thin amorphous Si (a-Si) film of 50 nm thickness was fabricated using radio frequency (RF) sputtering. The photoconductivity of poly-crystallized Si films after blue laser diode annealing (BLDA) has been measured and analyzed. As the laser power was increased from 4 to 6 W, the crystal structure changed from micro grains to laterally large grains. Photoconductivity value under the white light exposure of 100 mW/cm^2 reached as high as 8.1 x 10^{-4} S/cm for the Si film after H_2 annealing in H_2/N_2 (4%) ambient after subsequently after the BLDA at 6 W. Resultant photosensitivity ratio ($\sigma_{photo}/\sigma_{dark}$) of 94 was obtained owing to the reduction in the defects density in the Si films.

At first, ighly photosensitive Si film of new structure was successfully fabricated on glass by performing semiconductor BLDA. Simulation results showed 86% increase of light absorption in red or Infra-Red (IR) region by adopting back-reflection Ti layer. Peaks from X-Ray Diffraction (XRD) analysis results showed that Si film was crystallized clearly after BLDA despite the inserted new back-reflection layer of Ti on glass. After H_2 annealing, photoconductivity for the patterned Si films of 50 nm thickness prepared by photo-lithography increased remarkably up to 3.2 x 10^{-1} S/cm from 1.2 x 10^{-4} under white light of 100 mW/cm^2. These results suggest, adopting back-reflection layer under the crystallized Si film is promising to integrate functional photosensors with TFTs on panel. Thus, thin Si film crystallized using BLDA is promising for photosensor applications in a multifunctional system on panels.

Secondary, InSb films of III-V compound material were deposited on both mica and glass substrates using thermal evaporation and were subjected to Furnace Annealing (FA) or Rapid Thermal Annealing (RTA). Crystallinity, composition and electrical properties of the films were investigated. High value of electron Hall mobility as high as 25,000 cm^2/(Vs) was obtained with the capped InSb film by keeping the In:Sb ratio after RTA at 520°C for 30 sec without adopting epitaxial growth on single crystalline substrate.

Furthermore, InSb films were deposited using r.f. sputtering and effect of various deposition conditions such as gas species (Ne or Ar), gas pressure and film thickness were investigated. Both RTA and BLDA were used to crystallize the InSb films effectively. In the case of RTA, the obtained electron Hall mobility was 1,650 cm^2/(Vs) after annealing at 500°C for 30 s. Maximum electron Hall mobility of 1,050 cm^2/(Vs) was obtained after BLDA at 4 W for the InSb film sputtered using Ar gas at the pressure of 7.0 mTorr for the InSb film of 300 nm thickness. These results suggest that InSb film after RTA or BLDE is a promising candidate for IR sensor applications.

BLDA is a promising method to crystallize both Si or InSb films not only on glass but also on flexible plastic substrates, which can be applied for the fabrication of next generation SoP by integrating the sensors with TFT system.

These results can be expected as a functional sensor for SoP, as a TFT functional system which is also applicable for future Internet on Things (IoT) devices.

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