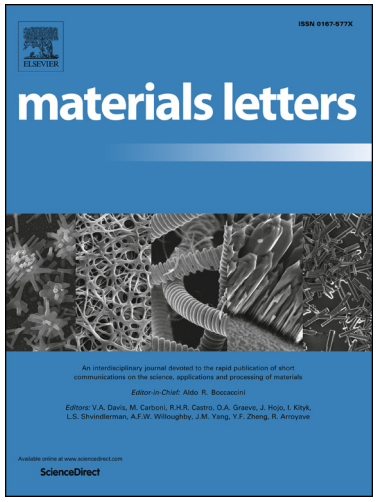

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Improved indium oxide transparent conductive thin films by hydrogen annealing

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ABSTRACT

In_2O_3 thin films were prepared by reactive evaporation with post-annealing treatment at forming gas of N_2 and H_2. After post-annealing treatment, the films annealed at forming gas achieved lowest resistivity of 2.70×10^{-4} Ω·cm. The XRD results show that the In_2O_3 films annealed in forming gas and N_2 with good recrystallization. In the forming gas annealing process, hydrogen plays a key role in the generation of oxygen vacancy and enhances the formation of In–OH bond which may influence the electrical and optical properties of the In_2O_3 films.

Keywords：Hydrogen, Indium oxide, Thermal annealing, Oxygen vacancies, Thin films, XPS

1. Introduction

Transparent conductive oxides (TCO) have been used in optoelectronic devices, such as thin films transistor [1] and heterojunction silicon solar cells [2]. Researchers had reported study of In_2O_3 thin films annealed in N_2, air [3], and vacuum [4], respectively. In previous studies, it was found that the chemical states and surface morphology of In_2O_3 films are strongly affected by the gaseous environment during the annealing process [5]. In this study, the In_2O_3 thin films were annealed forming gas and N_2 to investigate the influence of hydrogen on film properties of In_2O_3.

2. Material and methods

In_2O_3 thin films of 100 nm thickness were deposited on glass and polished silicon wafer. Prior to deposition, the chamber was pumped to 8×10^{-4} Pa, and indium particles of 99.999% purity were placed on a tungsten boat. High purity oxygen (99.995%) was used as reactive gas. As-deposited In_2O_3 was deposited by reactive evaporation, followed by furnace annealing in N_2 or forming gas of N_2 and H_2 (N_2 : H_2=90:10). As-deposited In_2O_3 films had a raw resistivity of about 5×10^{-2} Ω·cm and