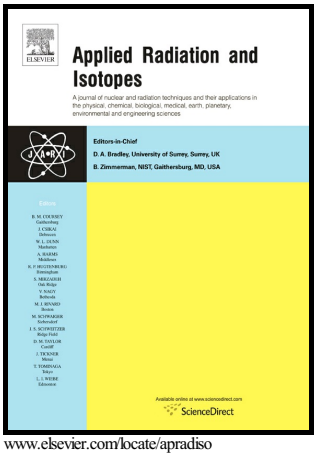

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Temperature-dependent thermal behavior of impurity hydrogen trapped in vacancy-type defects in single crystal ZnO

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ABSTRACT

Interacting nature between impurity hydrogen atoms and vacancy-type defects in single crystal ZnO was investigated by means of positron annihilation lifetime spectroscopy. In order to clarify the observation of their thermal behavior, the sample was implanted with $^{1}H^{+}$ using an electrostatic accelerator. After the implantation, the positron lifetime became shorter, which suggests that the hydrogen atoms were captured by zinc vacancies (V_{Zn}) to form vacancy-hydrogen complexes (V_{Zn} + nH). The complexes decompose by heat treatment: most of the hydrogen atoms gradually dissociate from V_{Zn} + nH in the temperature range 393-773 K. It was also suggested that large vacancy clusters were formed by the agglomeration of smaller clusters during the process of stepwise isochronal annealings at temperatures from 773 to 1,073 K, and their decomposition took place at 1,173-1,373 K. Temperature-dependent thermal behaviors of hydrogen atoms and vacancy-type defects in ZnO are discussed.

Keywords: ZnO, positron annihilation lifetime spectroscopy, impurity hydrogen, vacancy-type defects

1. Introduction

Zinc Oxide (ZnO) is a well-known semiconductor having a wide band gap of 3.4 eV at room temperature (Pearton et al., 2005). Due to the electric property of ZnO, its application to functional devices such as light-emitting diodes and transparent electrodes is highly expected. In regard to thin film transistors, ZnO attracts attention as a next-generation material replacing amorphous silicon because of its excellent electron field-effect mobility (Hossain et al., 2003). However, it is also known that ZnO shows persistent photoconductivity which induces a long-term relaxation of photocurrent and deteriorates the performance of transistors. It is suggested that one of