Investigation of Swift Heavy I-ion Irradiation Effects on Damage in Silicon Dioxide Thin Film

S. Intarasiri¹*, D. Bootkul² and U. Tippawan³

¹Science and Technology Research Institute, Chiang Mai University, Chiang Mai 50200, Thailand
²Department of General Science, Faculty of Science, Srinakharinwirot University, Bangkok 10110, Thailand
³PBP Research Facility, Department of Physics and Materials Science, Faculty of Science, Chiang Mai University, Chiang Mai 50200, Thailand

*Corresponding author. E-mail: saweat@gmail.com

ABSTRACT

Silicon dioxide (SiO₂) is a next-generation dielectric material for semiconductor processing. In particular, a thin film of amorphous-SiO₂ (a-SiO₂) on silicon wafers has many technological applications in microelectronics. However, a-SiO₂/Si structures can be severely degraded in the presence of radiation, due to the formation of defects in SiO₂ and its interface. In this study, we investigated the irradiation-induced defects of SiO₂ by swift I-ions. Thermally a-SiO₂ film was grown on Si wafer and subsequently irradiated with swift I-ions at energies of 10, 20 and 30 MeV at low or high fluences and at room or high temperatures. The effects of the irradiation were investigated following the changing of the infrared transmittance properties of the samples. From the measurements, we concluded that the energy, fluence and substrate temperature during irradiation greatly affected defects in the film. The electronic energy loss mechanism of the tens-MeV I-ion irradiation of a-SiO₂/Si structure plays a major role in the structure destruction.

Keywords: Silicon dioxide, Thin film, Ion irradiation, Swift heavy ions, Infrared spectroscopy

INTRODUCTION

A thin film of amorphous SiO₂ (a-SiO₂) on silicon wafers has many technological applications, especially in fabricating semiconductor devices. These applications include (Van Ommen, 1988) passivating the silicon surface for preventing uncontrolled potential fluctuations; acting as a diffusion barrier against the diffusion of impurities; acting as an insulating film between the metalization pattern, interconnecting devices and silicon substrate; and acting as a dielectric, insulating the gate from the substrate in field-effect devices. The effects of radiation on SiO₂/Si structures have been studied for many years. This steady interest reflects the importance of their practical applications. For example, Si integrated circuits