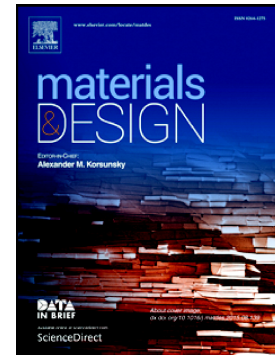


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Effect of thermal annealing on stress relaxation and crystallization of ion beam sputtered amorphous $\text{Si}_{1-x}\text{Ge}_x$ thin films

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Abstract

$\text{Si}_{1-x}\text{Ge}_x$ ($0 \leq x \leq 1$) thin films were deposited by means of biased target ion beam sputtering at a low substrate temperature near 100 °C inside a vacuum chamber. The as-deposited films were all found to be amorphous and to be compressively stressed, and the magnitude of the compressive stress was found to decrease with increasing Ge content. Heat treatment for 30 minutes under vacuum conditions in the range from 100 °C to 800 °C was found to relax the compressive stress and to eventually cause crystallisation of the films at higher temperatures. The temperature required to achieve full stress relaxation was found to decrease with increasing Ge content, and to be well below that for film crystallisation. Annealing at temperatures above the crystallisation temperature caused physical damage to films containing more than 50 at %Ge. Films with < 50 at % Ge showed no damage after annealing up to 800 °C.

Keywords: SiGe, thin films, biased target sputtering, stress relaxation, annealing

1. Introduction

$\text{Si}_{1-x}\text{Ge}_x$ thin films have attractive optical and mechanical properties for application in optical microelectromechanical systems (MEMS) technologies. These include a high refractive index in the range of 3.6 to 4.2 [1], negligible absorption at infrared wavelengths [1], high mechanical strength, and suitable Young's modulus [2, 3] enabling $\text{Si}_{1-x}\text{Ge}_x$ to serve as an optical and/or structural layer for free standing MEMS structures. Importantly, these materials are highly

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