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GENERAL FILM BEHAVIOUR

STRESSES IN THIN POLYCRYSTALLINE SILICON FILMS

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The mechanisms of generation and relaxation of stress have been studied in thin polycrystalline silicon (p-Si) films prepared by low pressure chemical vapour deposition (LPCVD) from silane in a horizontal reactor at residual pressures of 0.2–0.6 Pa and deposition temperatures of 853–943 K. The films were deposited onto silicon wafers overgrown preliminarily with an SiO_2 film 40–45 nm thick or an Si_3N_4 film 0.1–0.2 μm thick. It has been found that the basic contribution to the stress level is from an intrinsic compressive stress arising in the p-Si films because of their oxidation during deposition. Relaxation of stress occurs via the low temperature (grain boundary) dislocation climb mechanism. Minimum levels of stress are found when the growth of the LPCVD p-Si films occurs mainly as a result of a heterogeneous reaction at maximum temperature and minimum pressure of the residual gases.

1. INTRODUCTION

Thin polycrystalline silicon (p-Si) films are widely employed in microelectronics for the production of elements of large-scale integration (LSI) and semiconductor devices[1]. Therefore their physicochemical properties attract much attention from investigators. Stresses in thin p-Si films have been studied in refs. 1–6. However, the research concerned with the investigation of stresses in p-Si films has not treated the nature of the stress and the mechanisms of stress relaxation. Understanding of the nature and relaxation mechanisms of the stress is one of the prerequisites for the development and fabrication of LSI elements based on multilayered film structures of micron and submicron sizes. In this paper we attempt to find the mechanism of generation and relaxation of stresses in thin p-Si films prepared by pyrolysis of silane at a low pressure.

2. EXPERIMENTAL TECHNIQUE

Thin p-Si films formed by low pressure chemical vapour deposition (LPCVD) were prepared from gas mixtures containing 5% silane and 95% argon in a

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