Surface X-ray Diffraction Study of Insitu UHV-CVD Growth of Titanium Silicide

P. A. Bennett (Arizona State U.) and I. K. Robinson (U. of Illinois)

Abstract: benn1827
Beamline(s): **X16A**

Introduction: Titanium silicide $TiSi_2$ is widely used in the microelectronics industry to make contacts and interconnects in ULSI circuitry. Little is known about the initial stage of chemical vapor deposition (CVD) growth. Surface X-ray diffraction is ideally suited to monitor the crystallinity of the first few layers.

Methods and Materials: We used the standard precursor gases: $TiCl_4$ and Si_2H_6 with a simple UHV manifold and leak valves.

Results: We were unable to induce any measurable reaction with $TiCl_4$ up to a dose of $1x10^{-6}$ Torr * 60 sec on a sample heated to 900C as measured by Auger spectroscopy and LEED. We then tried a simultaneous dose of $TiCl_4$ and Si_2H_6. Again no reaction was observed until a dose of 10^{-4} Torr $TiCl_4$ and 10^{-5} Torr Si_2H_6 at 900C. This required backing the sample into the load lock, where no direct pressure measurement was available. Pressure was estimated by extrapolation of the leak rate * time. Following this dose, the sample was visibly altered and X-ray diffraction revealed mountains of polycrystalline silicon (Fig. 1). We then briefly studied the homoepitaxial growth of silicon. "Live" measurements of surface reflections during dosing showed a slow monotonic decrease without oscillations, indicating step flow with a gradual roughening on the surface. This occurs because growth temperatures sufficient to crack the disilane (600C) also lead to step flow. The resulting truncation rod is shown in Fig. 2. The loss of intensity in regions between the bulk Bragg peaks is characteristic of a rough surface.

Conclusions: Better luck next time. We need to have better control of gas handling in terms of adequate flow control at pressures higher than 10^{-5} Torr.

Acknowledgments: This work was partially supported (PAB) on NSF grant DMR9981779.

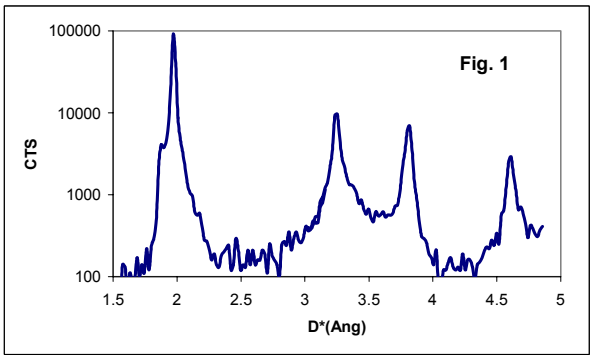

Figure 1. Radial scan following dose of $TiCl_4$ at 10^{-4} Torr, 900C. Peaks correspond to Debye rings for polycrystalline silicon.

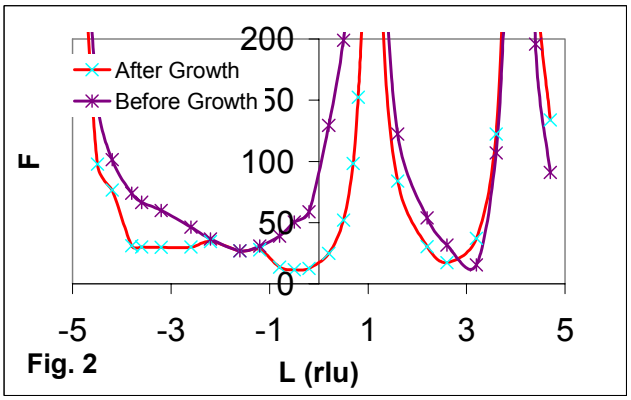

Figure 2. (1,0) truncation rod following dose of Si_2H_6 at 10^{-5} Torr, 600C. This shape is characteristic of a rough surface.