In-situ studying of crystal growth using TEM

ulm university universität ulm

Master Thesis, Electron Microscopy Group of Materials Science, Prof. Ute Kaiser

Background

Granular materials are very interesting from the point of their electrical transport properties. The system Ge:Al consists of crystals within an amorphous matrix. Under electron irradiation, Al particles start to crystallize out of Ge:Al amorphous films. Previous studies included the geometry and the dynamics of Al-amorphous interface with time resolution of 40 milliseconds by conventional bright-field (BF) and dark-field (DF) TEM imaging of films of 50 nm thickness and by conventional high resolution (HR) TEM of films of 25nm thickness at medium voltages between 200 and 300 kV. The propagation of the Al interface is diffusion controlled, i.e. the velocity is temperature dependent [1]. The Al-amorphous interface was found to be rough with a fractal dimension of 1.2 for the projected image [2]. However, the quantitative analysis of the interface propagation indicates a long range interaction in the Al-amorphous phase interface [3].

Aim

The aim of this studies is the investigation of Al:Ge films using aberration-corrected high-resolution HR-TEM to get further information about the growth processes of crystals on the atomic scale. Moreover, the influence of sample heating and sample cooling on the growth will be studied. Another set of parameter that triggers and changes the growth processes/rates are the electron energies of the irradiating beam. The higher inelastic losses of lower electron energies are able to produces local heating. Moreover, the sample thickness also determines the growth. For very thin samples (<10 nm) surface effects are expected and should change the growth rather than for thicker samples (> 50nm) were bulk properties are dominating.

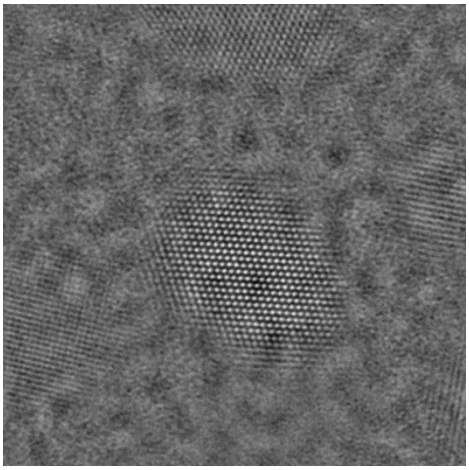

Fig 1. HRTEM image of high concentration Al nanoparticles embedded in a Ge:Al solution. Showing irregular distance between the particles with sub-nm scale.

Aim

1. Determination of the grain sizes and distances between the grains from bright-field, dark-field, and HRTEM images.
2. Atomic investigations of the interface crystal:amorphous film by HRTEM
3. Determination of the influence of experimental parameters such as temperature, electron energy, film thickness on the growth processes

4. Postulation of growth models

Workplan

- Introduction into TEM (bright-field dark-field, diffraction, HRTEM)
- Recording of TEM images
- Evaluation of the TEM images

Requirements

- Good understanding in physics
- Strong interest in laboratory work
- Strong interest in collaboration with foreign scientists

Supervisor: Dr. Johannes Biskupek (UUlm), Dr. Yossi Lereah (UTelAviv)

---

1. Y. Lereah, E. Grunbaum and G. Deutscher, Physical Review A 44 8316 (1991)
2. Y. Lereah, J.M. Penisson and A. Bourret, Applied Physics Letters 60 1682 (1992)
3. Y. Lereah, A. Gladckikh, S. Buldyrev and H.E. Stanley, Physical Review Letters 83, 784 (1999)