



Experiment title: Investigations of the first growth stages of GeMn on Ge(001)

Experiment number:
32 03 656

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Report:

Two GeMn samples have been grown and investigated during our experiment on SUV station on BM32:

- Sample called GM 216: 10 nm thick GeMn layer deposited on Ge(001), Mn concentration was 6% and sample growth temperature 100°C
- Sample called GM 218: 4 nm thick GeMn layer deposited on Ge(001), Mn concentration was 6% and sample growth temperature 100°C

Thermal treatment was performed in-situ for both samples in order to investigate manganese diffusion and subsequent Ge₃Mn₅ clusters formation.

All X-ray investigations were done at the beam energy of 11KeV and incidence angle close to the critical angle of 0.24°

Our GISAXS investigations (see figure 1) show two sets of correlation streaks: short range (about 10 nm) and long range (about 40 nm) streaks. Short range streaks can be tentatively attributed to the diffusion by the Mn rich nanocolumns. The distance between nanocolumns, which have been previously observed in our HRTEM images, is close to 10 nm. Long range correlation features (40 nm) do not correspond to any known substructure in our GeMn layers. In GISAXS images in [100] direction one can see also a pronounced scattering induced by facettes.

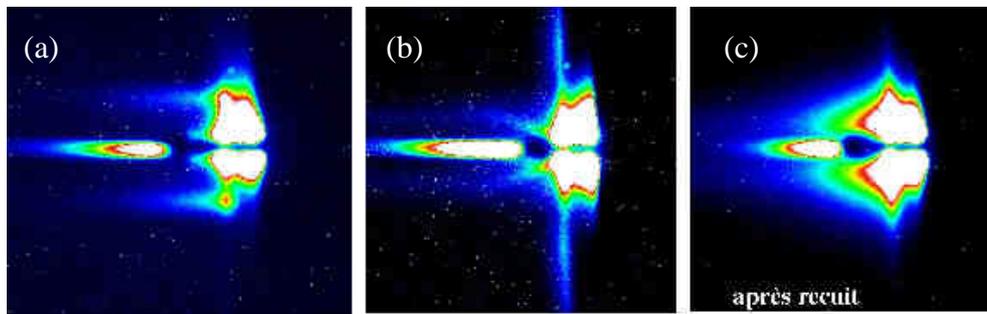


Figure 1: GISAXS picture taken before (a,b) and after (c) annealing.

Thermal treatment of this samples at relatively high temperature of 300°C induces a very important modifications of the GISAXS images:

- Short range correlation streaks disappear
- intensity of the long range correlation streaks is strongly reduced
- streaks corresponding to facets disappear

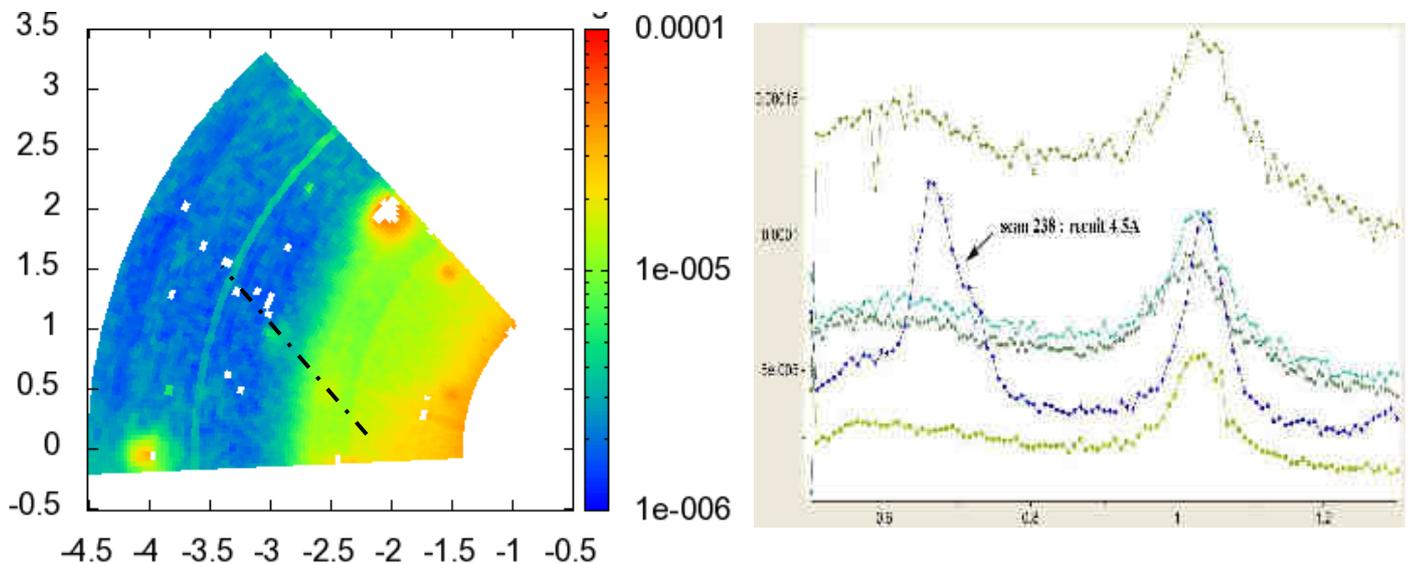


Figure 2.:(a) in-plane reciprocal space map between (-220) and (-400) (b) evolution of the scans between (-310) and (-2.5 0.5 0)

Our GIXD investigations performed on (-220) and (-400) Bragg peaks (radial and angular scans) also indicate short and long range correlations, which are strongly affected by thermal treatment. Moreover, (-220) and (-400) Bragg peaks are highly asymmetric before thermal treatment.

We also made an in-plane map around (-220) and (-400) Bragg peaks (see figure2(a)). In this map we observed two weak and broad peaks located at $(h=-3 ; k=1)$ and $(h=-2.5 ; k=0.5)$. Their intensity strongly evolve after thermal treatment (see figure 2(b)).

General conclusion of our preliminary investigations is that in order to extract structural informations concerning our GeMn samples we have to investigate samples grown at different conditions i.e. different substrate temperatures and with different Mn concentrations. Thermal treatment performed *in-situ* in SUV diffraction chamber provide also very interesting informations which have to be confirmed by HRTEM observations. Anomalous aspect of GID and GISAXS should be also exploited.