



	Experiment title: Structure determination of GeMn nanocolumns using the pair distribution function method	Experiment number: HE-2960
Beamline: ID 31	Date of experiment: from: 20/11/2008 to: 26/11/2008	Date of report: 31/08/2009
Shifts: 18	Local contact(s): Andy Fitch	<i>Received at ESRF:</i>
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Report:

We have performed the measurement of the in-plane Pair Distribution Function (PDF) in GeMn nanocolumns. The nanocolumns were obtained by low-temperature Molecular Beam Epitaxy of Ge and Mn atoms on Ge(001) substrates. Due to a spinodal decomposition process, the GeMn nanocolumns are embedded in a crystalline Ge matrix. However, the crystalline structure of the nanocolumns is still unknown. Depending on the growth conditions, the columns either look crystalline or amorphous. PDF can then be a tool of choice for determining the short-range order within the columns and/or the distorted surrounding matrix.

We have measured different samples:

- GM197 : GeMn layer with 3-nm wide crystalline nanocolumns, protected from oxidation by an amorphous Si layer.
- GM169 : GeMn with large (6 nm) amorphous nanocolumns
- GM211, GM271 : GeMn/Ge layers with different growth parameters
- GM205 : Ge substrate
- GM209 : diluted sample (<1% Mn in the layer)
- GM201 : crystalline Ge₃Mn₅ thin film, grown over Ge(111). It is a stable (Ge,Mn) compound.
- Si reference

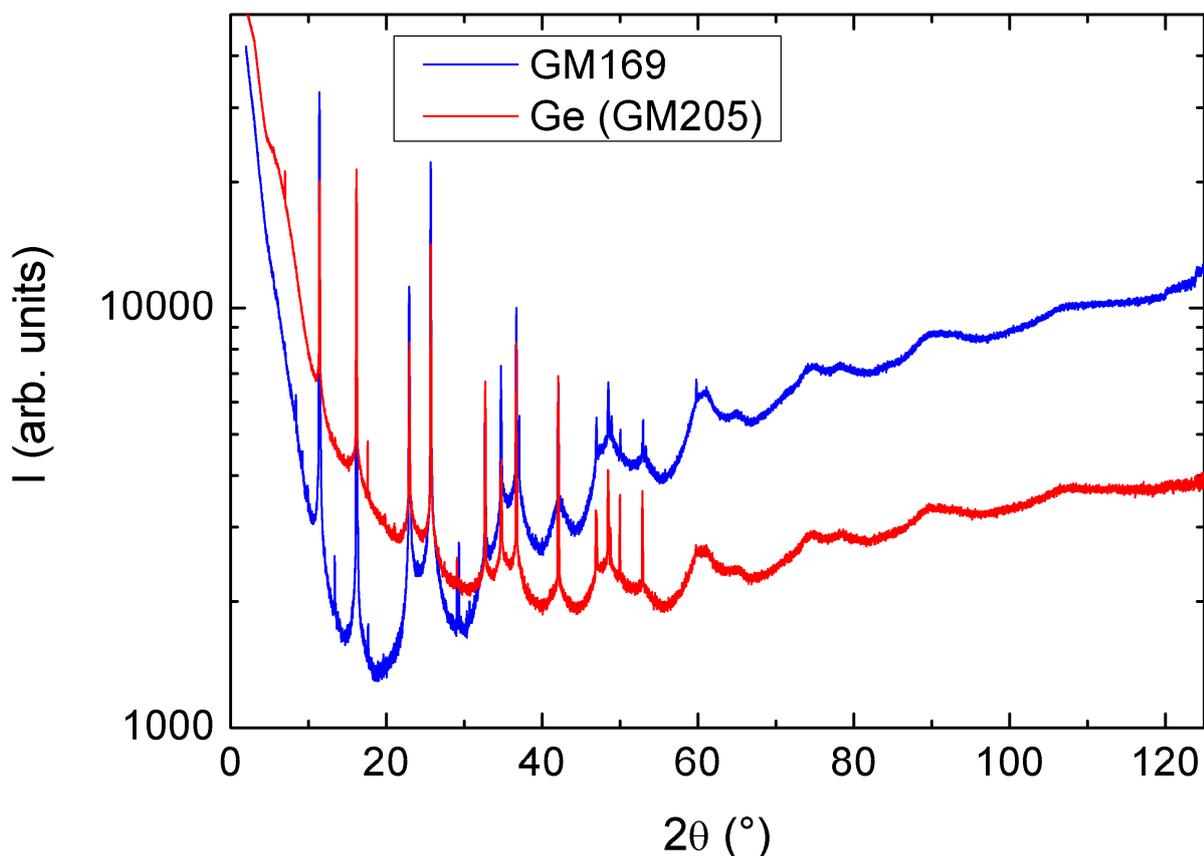
We have also performed the experiment without any sample, in order to measure the diffuse background.

The experimental set-up was slightly different from that of a classical PDF experiment. The samples - in the form of flat-plates - were held under grazing incidence (0.4°) and rotated around the normal axis of the surface, in order to average the in-plane distances.

The PDF analysis of the data requires a high Q range, typically up to 30 \AA^{-1} . Therefore we have used the high energy photon beam and the wide two-theta angle available at ID31.

The two-theta angle was scanned from 0 to 120° and the scans were repeated several times and averaged. The high-angle region (from 60 to 120°), i.e., the low intensity region, was measured twice as much. The scattered intensity was measured using the Debye-Scherrer mode. For the capped sample GM197, several incidence angles, ranging from 0.1 to 0.5° , were measured.

The measured data were extracted from the raw data using the software available at the beamline. No new peak corresponding to a new crystalline phase could be observed. However we evidenced the presence of In crystals in some samples. Those are likely leftovers from the indium gluing before the growth. Moreover, no parasitic Ge_3Mn_5 phases were observed in the GeMn samples. The analysis of the diffuse scattering using the *PDFgetX2* code is currently in progress.



In-plane PDF measurement in the amorphous nano-columns sample (blue) and the Ge substrate (red)