Анализ дифракционных картин при синтезе наногетероструктур Ge/Si

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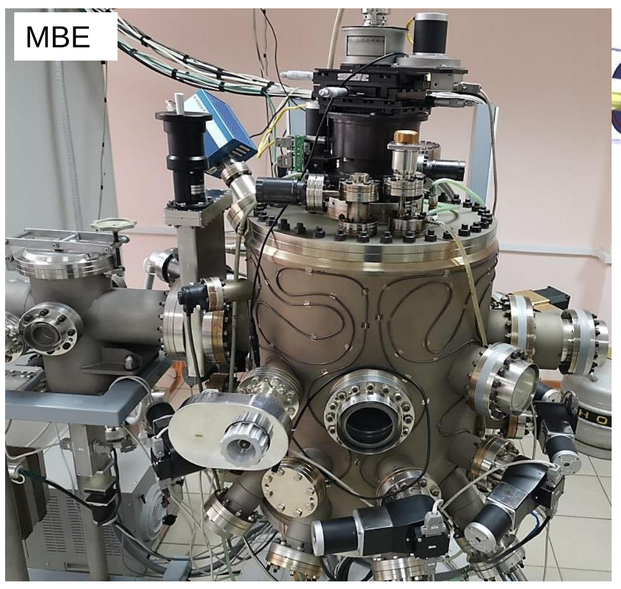
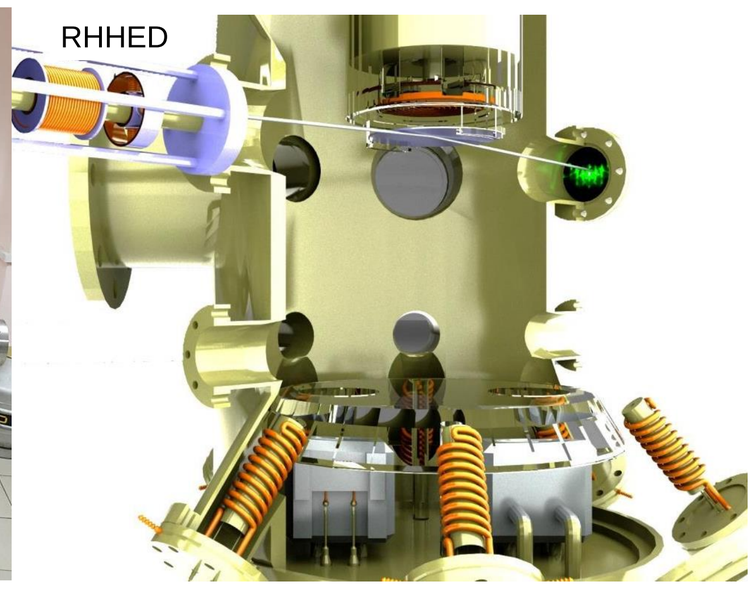
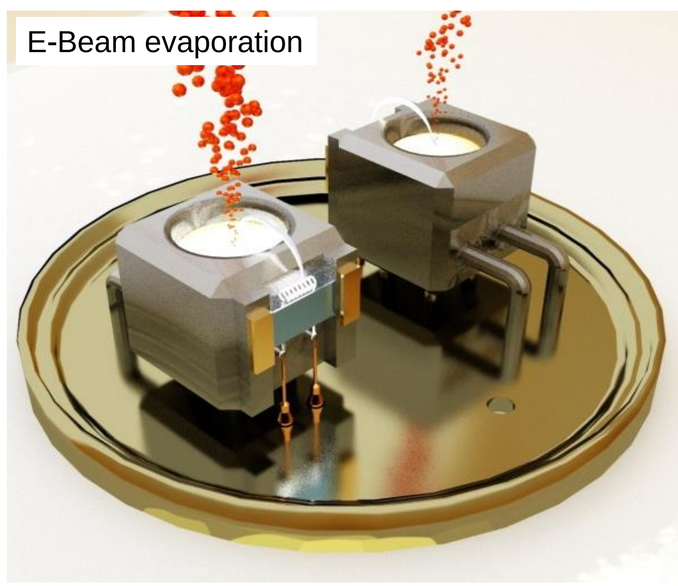
Molecular beam epitaxy

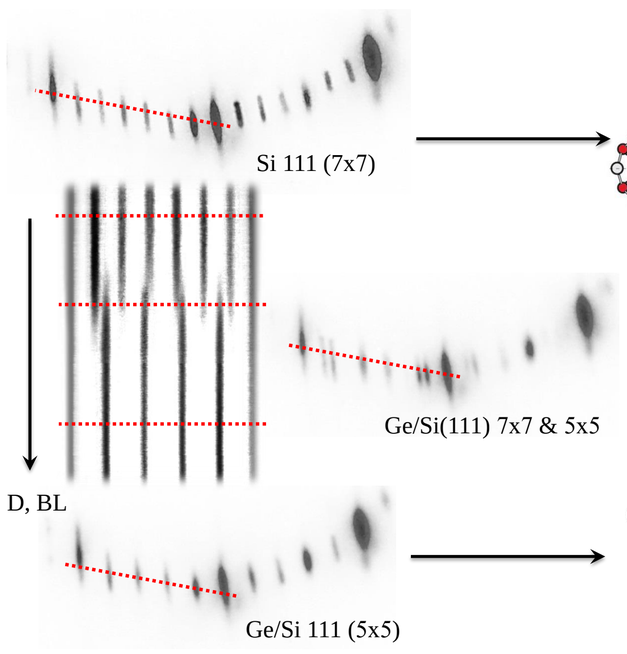


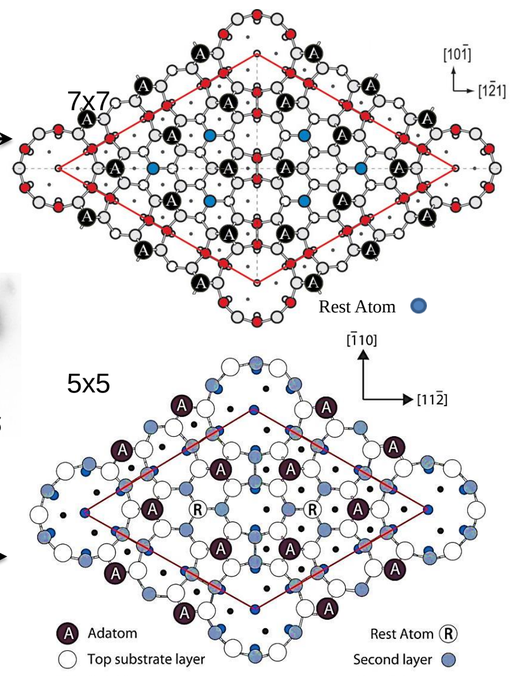




- Ultra-high vacuum
- Low growth rates
- Low temperatures
- Possibility of abrupt interruption and resumption of growth processes
- Analysis and control during growth
- **High quality** of nanostructures

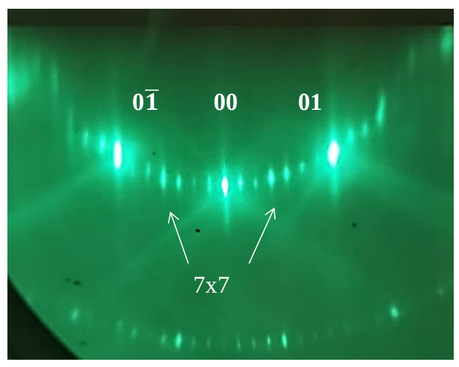
Highlights of changes in diffraction patterns in the synthesis of Ge / Si (111)





During the synthesis of Ge on Si 111, a superstructure transition occurs after a lattice constant mismatch by 4%, and the Stranski-Krastanov growth process occurs.

https://www.physics.queensu.ca/~nanophys/papers.html



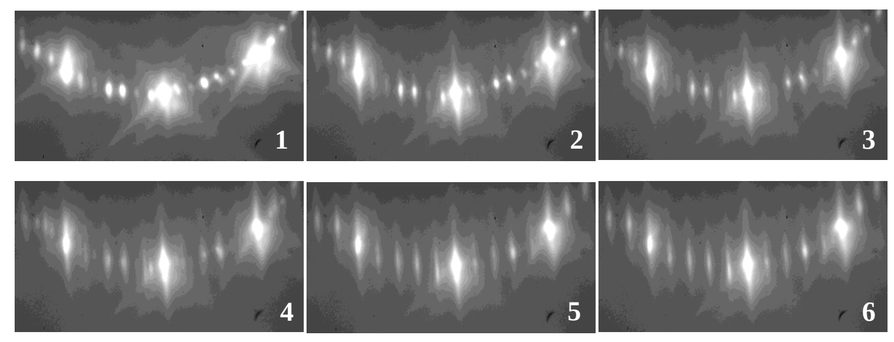
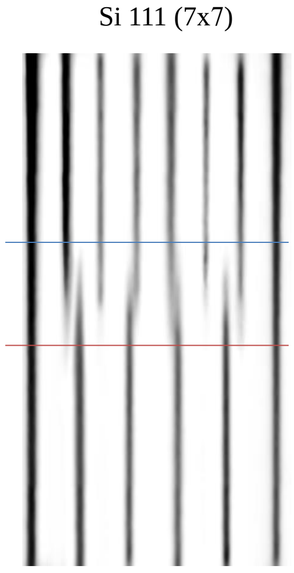


Figure 1. Highlights of changing diffraction
1. Picture from a clean Si (111) surface with a 7x7 superstructure.
2. The pattern from the surface during the initial deposition of Ge is accompanied by the "stretching" of the reflections.
3. Picture with the beginning of the transition of the superstructure 7x7 to 5x5.
4. A picture with a predominant manifestation of the 5x5 superstructure.
5.The pattern from the surface of the Ge layer is about 10 Å with a 5x5 superstructure.
6. The picture with the emergence of hut clusters.

Analysis of the transition time of the 7x7 - 5x5 superstructure in the synthesis



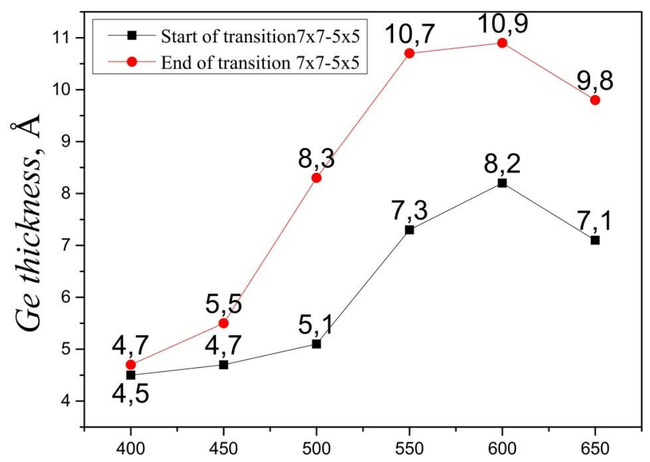
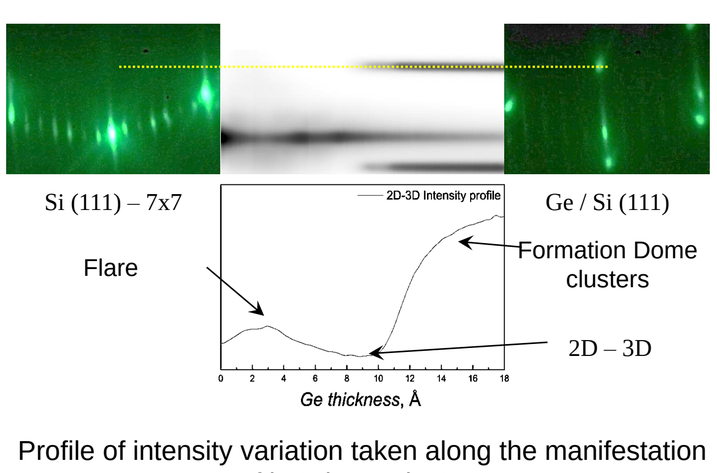


Figure 2. Dependence of the critical thickness of the germanium layer with a 7x7 superstructure on the Si (111) substrate temperature.



Profile of intensity variation taken along the manifestation of hut-dome clusters

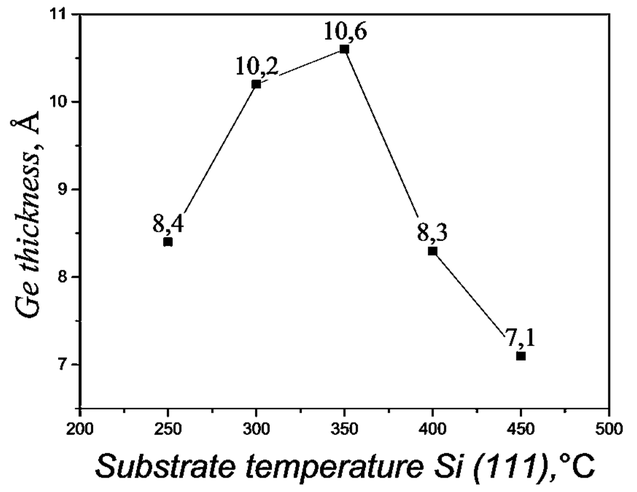


Figure 3. Dependence of the critical thickness of the 2D germanium layer on the Si (111) substrate temperature.

Thus, at low temperatures, the transition of the superstructure occurred at a germanium layer thickness of about 4.7 Å. With increasing temperature, the thickness of the germanium layer with a superstructure of 7x7 increased and reached was 8,2 Å at a temperature of 600 ℃ . In this case, the complete transition of the superstructure occurred at a single atomic layer of germanium.

An analysis was made of the transition from 2D to 3D growth in the synthesis of Ge on Si (111) in the substrate temperature range from 250 to 450 ℃. The maximum critical thickness of the germanium layer is observed at 350 degrees and was 3.4 bilayers.

Conclusions

Thus, the paper presents the results of the study of the transition of the 7x7 to 5x5 superstructure during the synthesis of Ge on the Si(111) substrate by the reflection high-energy electron diffraction method. The dependences of the transition of the 7x7 to 5x5 superstructure at different temperatures of the silicon substrate were obtained. The critical thickness of the stressed heteroepitaxial layer Ge and a change in the parameter of an elementary two-dimensional cell during the growth of Ge on Si (111) were also determined during the experiments.