In situ fine pattern formation process of GaAs/AlGaAs using focused-ion/electron-beam

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Yoshimasa Sugimoto

The present thesis concerns fine pattern formation and overgrowth using *in situ* vacuum processes for the formation of GaAs/AlGaAs low-dimensional structure such as quantum wires.

An *in situ* patterning process in an ultrahigh-vacuum (UHV) environment is likely to be useful for the fabrication of quantum fine structures. The greatest advantage of an *in situ* process is in its capability to repeat epitaxial growth and microfabrication without unintentional surface contamination caused by air exposure. A UHV multichamber system used for this *in situ* process is described.

As means of realizing the maskless etching, the focused-ion-beam (FIB)-assisted Cl_2 etching for GaAs and AlGaAs is one of the candidates. In order to reduce induced damage, it is proved that low energy, high etching yield and high substrate temperature conditions are necessary. It is also described on *in situ* process that includes patterning by FIB-assisted Cl_2 etching and subsequent overgrowth.

Novel *in situ* process named"*in situ* electron-beam (EB) lithography" is also investigated as a candidate for damage-free pattern formation process. In this process, an ultrathin GaAs oxide at the wafer surface is used as a resist film. The GaAs oxide resist prevents Cl_2 etching of the underlying GaAs and is locally removed for patterning when the EB impinges on the surface under a low Cl_2 gas pressure. This EB induced removal of the oxide resist results in selective etching of underlying GaAs by Cl_2 gas exposure. The feasibility of the present process for devices is demonstrated by the formation of buried quantum-well structures.