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Ultrafine Fabrication Technique for Hot Electron Interference/Diffraction Devices

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Ultrafine fabrication technique for hot electron interference/diffraction devices have been developed. Alignment of buried fine structure and mesa with accuracy of 100nm is reported for the first time.

By using state-of-art ultrafine fabrication techniques, there is possibility of observation of hot electron diffraction/interference in semiconductors. We propose here the experiment for such observation by man-made structures. According to our theoretical analysis, when phase breaking time of hot electron is 0.2ps, interference pattern caused by double slit of 30nm-spacing can be detected by 50nm-pitch stripe electrodes(Fig.1). Nanometer alignment technique is very important to make this device. We have developed a new technique for the alignment of the electron beam lithography(EBL) in buried nanometer structure.

200nm thick Tungsten cross mark was formed on GaInAs/InP heterostructure by spattering and lift off, because conventional gold mark was melt during regrowth. By detecting these marks, 100nm-pitch grating was and fabricated by using EBL and precise wet chemical etching[1)] at the defined position. Then the grating was buried with GaInAs by organometallic vapor phase epitaxy regrowth technique. There were no growth of GaInAs on the tungsten marks nor deformation in the shape. Again, by detecting the marks, a mesa of 800nm width located above fine grating was formed by EBL and wet chemical etching. Figure 2 shows cross sectional view of the structure. The center of the mesa is aligned with that of the grating with the accuracy of 100nm.

As to electrode for the detection of the electron interference/diffraction pattern, a grating electrode of pitch as fine as 50nm was formed on InP mesa.

By using techniques we have developed, it may be possible to perform the Young's experiment for the hot electron waves in the solid.

1)T.Yamamoto, et al., Electron. Lett.26 875(1990).

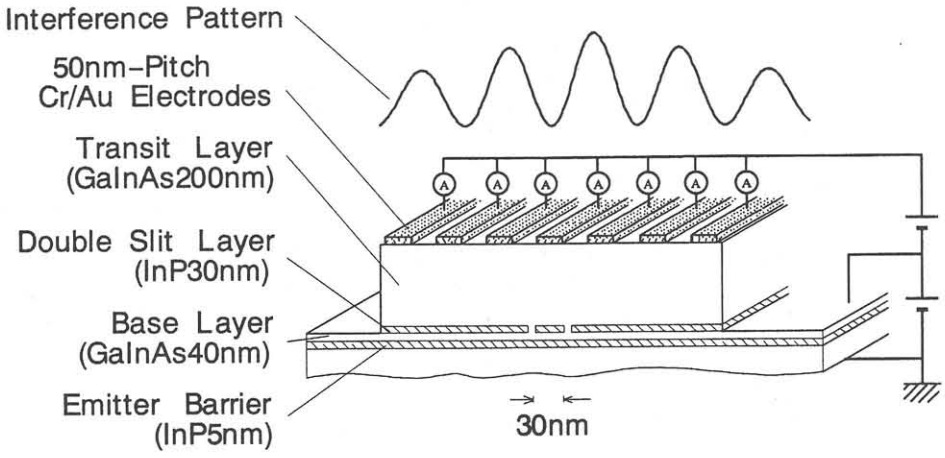

Fig.1. Proposed device structure for hot electron interference by double slit.

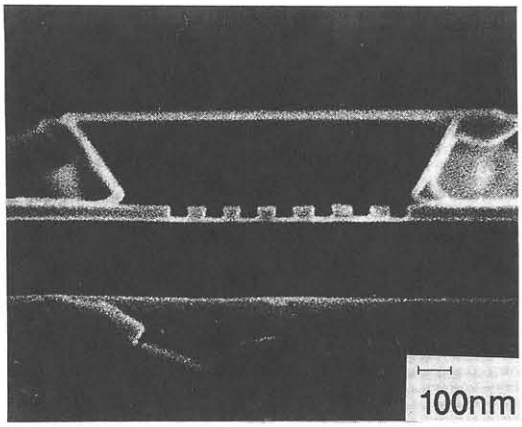

Fig.2. Cross section SEM view of 50nm line-and-space buried structure and 800nm mesa with aligned accuracy of 100nm.

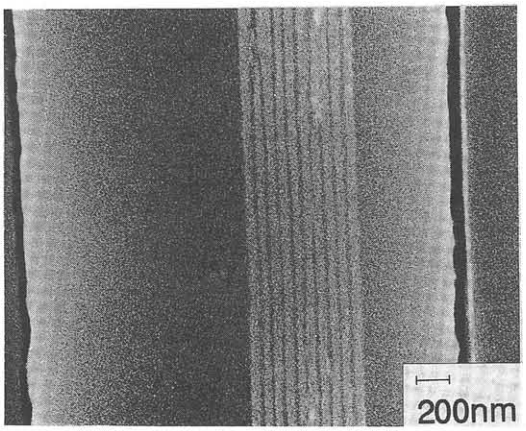

Fig.3. Formation of 25nm line-and-space Au/Cr electrodes on 1μm InP mesa.