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Shaped Mesas on Gallium Arsenide

Gallium arsenide is now widely used to make microwave semiconductor devices and is of interest in acoustic surface wave research. A preferential etching effect which we have observed is of interest in both areas.

The etch used was potassium cyanide, hydrogen peroxide and water (15:400:400 parts by weight). At room temperature (24°C) the etch rate on the (100) face of GaAs was 2.6 μm/min. Conventional positive photoresist techniques were used to define the mesa pattern. The effect observed with a circular mesa is shown in fig. 1. The [110] direction was determined from the cleavage behaviour of the GaAs slice. Fig. 2 shows scanning electron microscope photographs of (*a*) an outward sloping section (*b*) a vertical section and (*c*) an inward sloping section. This behaviour can be explained in terms of preferential etching of the (111) planes when etching the (100) surface. Fig. 3 shows the four (111) planes in the GaAs (Zinc Blende) structure, with the two [110] directions which fall in the (100) plane. When etching a circular mesa an etchant which attacked (111) planes only would give two inward sloping sections on opposite sides of the mesa at 54° 45′ to the surface of the sample, parallel to the [110] direction. Two similar outward sloping sections would be formed perpendicular to this [110] direction. This is just the observed behaviour shown in figs. 1 and 2a, b and c.

Fig. 2d shows a shaped mesa on epitaxial gallium arsenide used to make Schottky barrier gate field effect transistors. The sloping edges (at both ends of the mesa) allow evaporated metal leads to be taken from the transistor over the edge of the mesa to contact bonding pads on the semi-insulating substrate. This gives an important reduction in interelectrode capacitances.

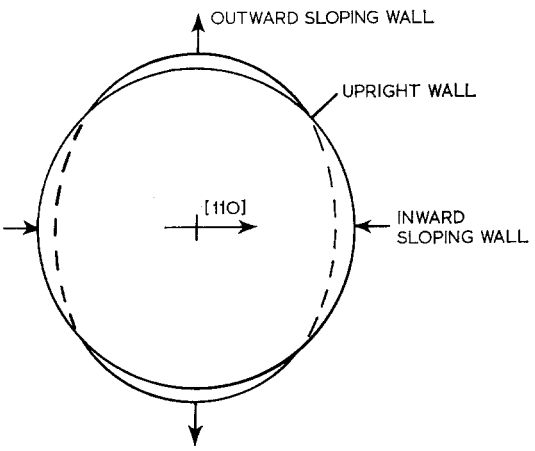

Figure 1 Etching effect observed on a circular mesa.

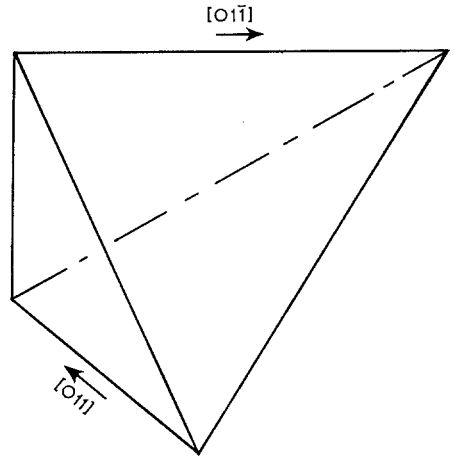

Figure 3 The four (111) planes in GaAs and the two [110] directions which fall in the (100) plane.

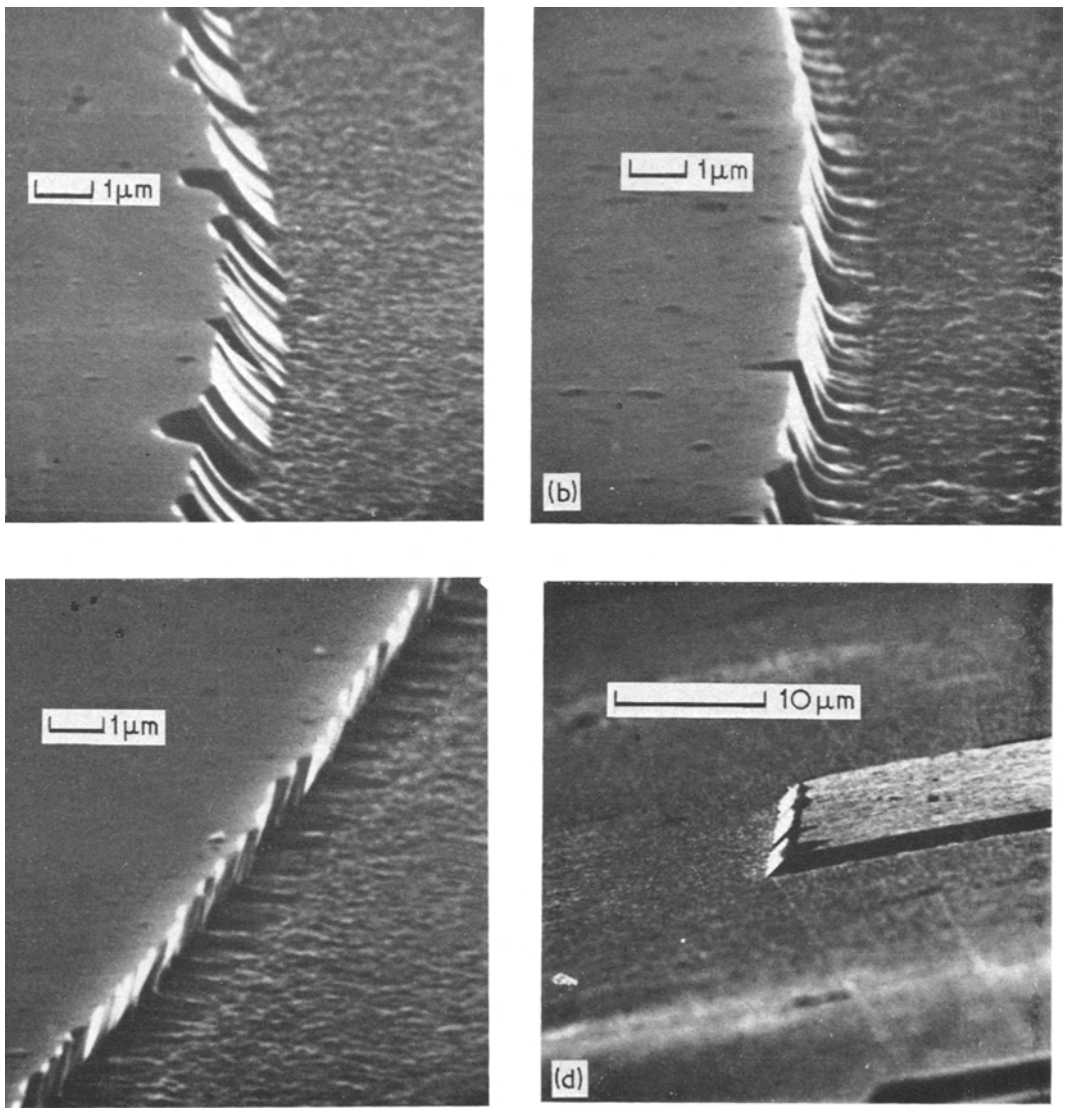

Figure 2 (a) Outward sloping section of the mesa. (b) Upright section of the mesa. (c) Inward sloping section of the mesa. (d) Edge of a rectangular mesa with one side parallel to the [110] direction.

A long mesa with undercut sides may be used as a microwave frequency acoustic surface wave guide. It is also feasible to make gratings for the conversion of surface to bulk acoustic waves using this technique.

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