Anderson's[1] theory was apparently formulated to explain the special case in the Ards Peninsula; it has no general application and I consequently doubt its specific application.

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PHYSICS

Ultrasonically induced Etching of Quartz

SOUND waves have been excited in quartz from 20 kc/s to 3,000 Mc/s. Frequencies of greater than 20 Mc/s are usually excited either by placing a quartz rod in a re-entrant cavity and exciting the surface layer[1], or by exciting 1–10 Mc/s quartz plates at high odd harmonics[2]. Both these methods suffer from the fact that the acoustic power produced is only of the order of mW/cm^2. A distinct improvement in power level is obtained if the quartz is excited at its fundamental frequency[3]. This frequency is, of course, dependent on the thickness of the quartz plate—the latter is equal to half the wave-length for this frequency in the quartz. Difficulties arise because for frequencies above 10 Mc/s the thickness of the quartz plate must be less than 0·3 mm. However, by conventional grinding techniques, using fine 'Carborundum' powders, thicknesses as low as 150μ can be achieved. To obtain thinner plates, of higher fundamental frequencies, is exceedingly difficult, and requires very expensive machinery. Quartz, because of its brittleness, is easily broken during grinding, especially because of the large particle size of even the smallest 'Carborundum' particles ($3F$ graded grit sizes average 13μ and may be as large as 25μ). Even after polishing the ground quartz, deep score marks are visible on its surface.

One solution to this problem devised in this department is the use of an etchant liquid agitated by 40 kc/s sound waves. The apparatus is shown in Fig. 1. The 40 kc/s transducer must be plated with a material resistant to the liquid etchant used. In the case of quartz a suitable etchant is hydrofluoric acid, and the faces of the transducer are plated with copper. A mixture of 40 per cent hydrofluoric acid in water has been found to be the best for etching quartz. For appreciable etching to occur, the vibrating face of the 40 kc/s transducer must be only a short distance, h cm, from the quartz surface. The theory of acoustic streaming, which describes the production of a steady flow of fluid from an alternating pressure field, predicts that the streaming occurs very close to the vibrating surface. The streaming is especially marked in a thin layer of fluid on the vibrating surface. The thickness of this layer at 40 kc/s is calculated to be about 10μ, which is approximately equal to the experimentally established distance h already mentioned. This fact clearly implicates acoustic streaming as the agent for enhancing etching. Nyborg[4] has commented that acoustic streaming would greatly increase the rate of such mass transfer processes, and has ascribed the removal of loosely adherent films to boundary layer streaming[5]. This is precisely the effect needed here.

Two precautions must be observed. The first concerns the production of small bubbles in the sound field which cause large local increases in fluid velocity and thus in mass transfer processes occurring near their surfaces[6].

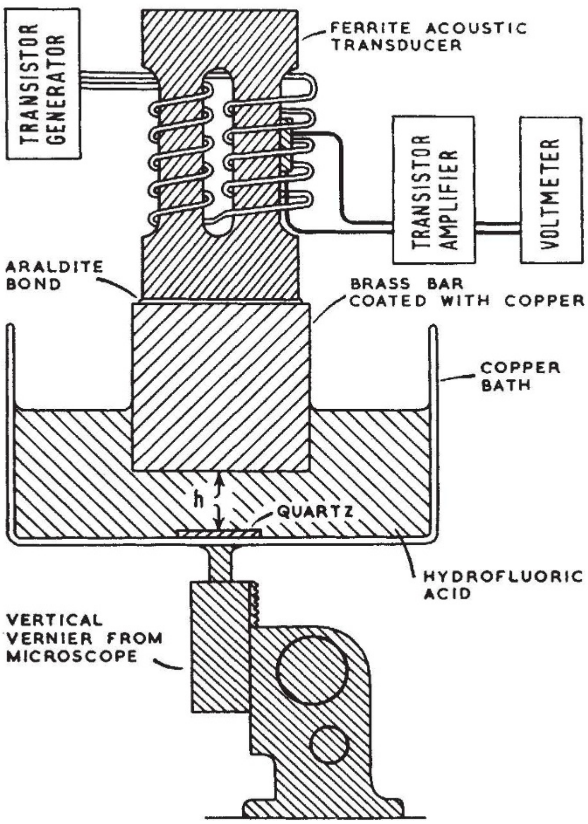

Fig. 1

This can be avoided by the use of very low acoustic powers from the transducer—certainly no higher than 0·5 W/cm^2—or by establishing static pressures up to 10 atm. in the treatment vessel. Secondly, the diameter of the transducer head must be more than three times the diameter of the plates being etched. The reason for this is that the acoustic field must be relatively uniform over the quartz surface, for the sharp fall which occurs at the perimeter of the transducer must be avoided.

By this method, quartz sections 50μ thick have been readily obtained here for frequencies up to 90 mc/s. Plates for even higher frequencies could doubtless be obtained by the etching technique described, which could indeed be utilized for many purposes where the production of very thin plates is a requisite (for example, hard biological tissues, metals).

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Direct Current Electroluminescence in the Zinc Sulphide/Copper/Manganese System

WORK on electroluminescence at the AEI Central Research Laboratory has been aimed at producing layers for a solid-state image intensifier. These usually consist of a combination of an a.c. electroluminescent layer with a photoconducting layer. To avoid the problems associated with capacitive coupling we have concentrated our attention on electroluminescent layers which operate