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Technical note

A simple tissue-like ultrasound phantom material

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Routine testing and calibration of modern grey-scale ultrasound scanning equipment and the training of operators in its proper application can often benefit from the use of tissue-like phantoms. For example, checking of display systems, simple registration checks or familiarization with the operation of scanner controls to achieve optimal results, can all be performed with this type of phantom. Another application is as a standard for ultrasonic tissue characterization studies.

By "tissue-like" is meant a phantom that produces a B-scan appearance similar to that from the parenchyma of an organ such as the liver, *i.e.* a finely textured echo pattern. Experimentally it is found that this can be achieved using a scattering structure of characteristic dimensions close to, or less than, the ultrasonic wavelength. The present lack of understanding of the nature of the ultrasonic scattering by tissue means that it cannot be assumed that the imaging process is the same for the scattering phantoms as for tissue. Consequently machine performance in tissue cannot be predicted from the phantoms. Nevertheless, as stated above, these scattering phantoms can be very useful in routine testing and calibration if care is taken not to overinterpret the results.

Several such phantoms are now commercially available, usually based on a suspension of graphite particles or glass microspheres in a gelatin matrix. A "recipe" for their construction has been given by Madsen *et al.* (1978). The disadvantage of these structures is their relatively high purchase price and the difficulty of mastering their construction as a home-made item. In particular, uniformity of the particle suspension is difficult to achieve. This communication deals with the use of special plastic foam material called reticulated foam which has an open-pore structure and a uniform pore size and produces very good tissue-like ultrasonic scans.

Figure 1 shows the reticulated foam material Bulpren S20† which is a polyurethane foam. Its industrial application is as an air filter and it is guaranteed to contain only open pores. This will ensure complete filling with fluid. It is available in a range of thicknesses and pore sizes and is very easily cut and shaped. We have used an electric carving knife to accomplish this.

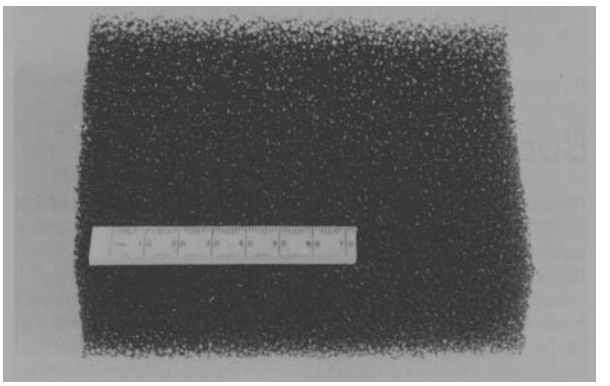

FIG. 1.
Reticulated foam Bulpren S20.

The attenuation of ultrasound in the reticulated foam in water has been measured using the method described by Madsen *et al.* (1978) and is compared in Fig. 2 with their data for graphite/gelatin mixtures. Bulpren S20 and S10 are shown, which have pore sizes of about 2.5 mm and 1.25 mm respectively. To assess the change in ultrasonic velocity for the foam phantom over the immersion fluid the following experiment was performed. The transit time of an ultrasonic pulse was observed on an oscilloscope for a 10 cm water path at 20°C. A foam sample of the same thickness was inserted into the path and the shift of the ultrasonic pulse observed. For both types of foam this shift was less than 1% of the total transit time and consequently it may be concluded that the velocity change is of the same order.

Figure 3 shows a grey-scale B-scan of the above reticulated foam material together with one from a commercial gelatin suspension phantom.* A Technicare EDP 1000 B-scanner with the same settings except for overall gain was used for both scans. Clearly the ultrasonic attenuations are comparable. For this demonstration the reticulated foam was immersed in a solution of chlorexidine gluconate in distilled water (Hibitane 0.5% w/v). In the commercial phantom used here an American Institute of Ultrasound in Medicine (AIUM) 10 cm test object is included; this could easily be done for the

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† Bulpren reticulated foam is available from Foam Engineers Ltd., Dashwood Avenue, High Wycombe, Bucks, England.

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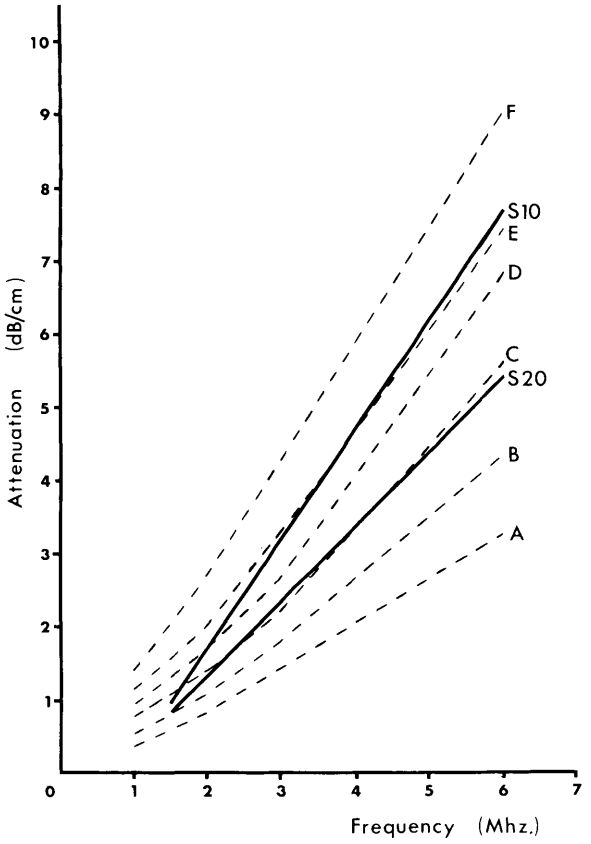

FIG. 2.

Ultrasound attenuation in foam Bulpren S10 and S20 compared with Madsen gelatin/graphite mixtures A to F.

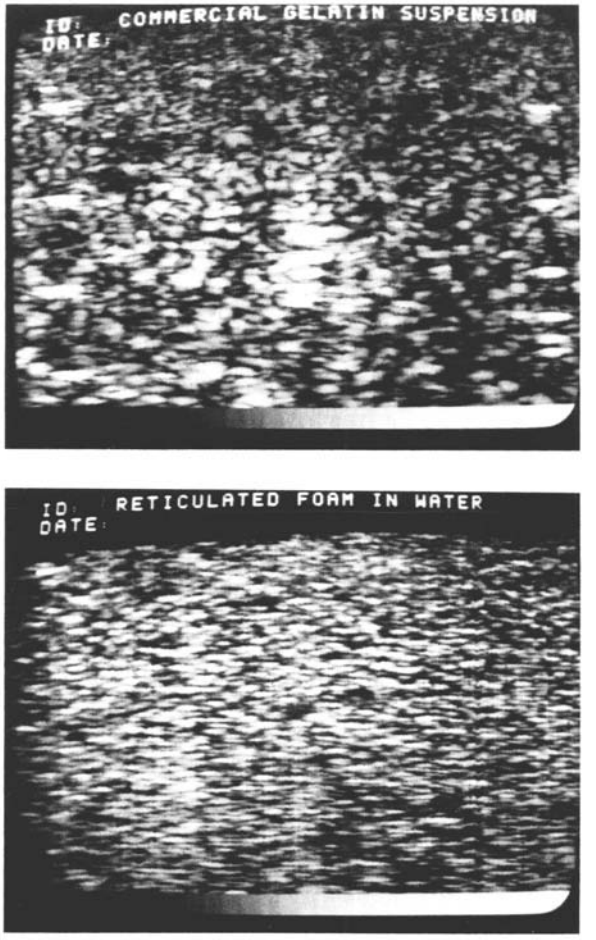

FIG. 3.

Grey-scale B scan of reticulated foam (lower) and commercial gelatin phantom (upper). Recorded at 3.5 MHz with Technicare EDP 1000 scanner. Note that the commercial phantom includes an AIUM 10 cm test object.

reticulated foam. It should be noted that the foam phantom gives a more uniform fine texture pattern which we would suggest is more liver-like than the gelatin suspension and more useful in the standardization of tissue characterization studies.

Finally we have constructed a phantom of reticulated foam sealed in a perspex container immersed in Hibitane solution. This is easily portable and scanning may be performed through the perspex lid. It is also possible for the foam to be potted in gelatin.

REFERENCE

MADSEN, E. L., ZAGEBSKI, J. A., BANJAVIC, R. A. & JUTILA, R. E., 1978. Tissue mimicking materials for ultrasound phantoms. *Medical Physics, 5,* 391–394.