Low Attenuation Polymer Wedge Transducer for Exciting High Intensity Surface Acoustic Waves on Glass Plate

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Background, Motivation and Objective

Front view camera has become an essential device for automatic cruise system of vehicles. To ensure clear view, obstacles such as droplet, snow and other objects on the front shield need to be removed automatically since the cameras are equipped behind the shield glass. The authors are trying to utilize high intensity surface acoustic wave (SAW) to remove water droplet on a glass plate because most of the vehicle's front shield is triple-layered. Polymer layer inserted between two glass plate exhibits very high attenuation at ultrasonic frequency. SAWs can be excited on non-piezoelectric substrate by using wedge transducers, and have been used for non-destructive evaluation and touch sensors. The sound speed in the wedge needs to be lower than the SAW velocity of the glass (=3420 m/s), and PMMA (polymethyl methacrylate) have been usually used for the wedge. But the attenuation in PMMA is too high to transmit high intensity ultrasonic vibration. In this report, we carefully choose the low loss wedge material and demonstrate removing water droplet on a layered glass.

Statement of Contribution/Methods

In our previous study on Q factors of several kinds of polymers[1], we found that PPS (polyphenylene sulfide) showed considerable high Q factors at several 10 kHz in comparison with other popular engineering plastics such as PEEK, POM and ABS. PPS exhibits Q factor of 300 even under high vibration strain of 0.02% to 0.03%. We have chosen PPS for the wedge, and determined the longitudinal sound speed through pulse-echo method at 2.25 MHz to be 2435 m/s. Using this value and the SAW velocity on the glass plate, the wedge angle was calculated to be 45.4 degrees. The SAW wavelength should be shorter than the thickness of the top glass (=2 mm) since the most of the vibration energy is confined in the depth less than one wavelength from the surface. Considering this condition, the frequency of excitation need to be higher than 1.6 MHz.

Results/Discussion

Thickness of the piezoelectric ceramic plates were varied to test three different frequencies, 1.67, 2.00 and 2.50 MHz. Wedges with three angles 43, 45 and 47 degrees were prepared for the experiments. As expected by the theory, the 45-degree wedge exhibited the highest vibration velocity on the glass surface and most effective to remove water droplets from the propagation path of the SAW. The transducer with the lowest frequency showed better results than the higher frequencies. This can be attributed to higher attenuation in the wedge for higher frequencies. Reducing the height of the wedge and widening of the active region on the glass will be considered in near future.

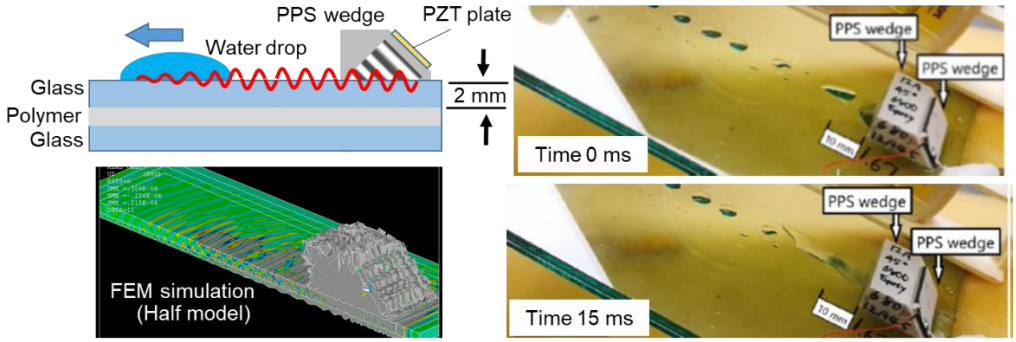

Fig. 1 Wedge transducer on triple-layered glass (left) and snap shots from the movie file (right).

Reference

[1] J. Wu, et al., Measurement of mechanical quality factors of polymers in flexural vibration for high-power ultrasonic application, *Ultrasonics* 2016, 74-82.