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Dual frequency ultrasound - a pulse-echo technique for analysis of layered material

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Ultrasound (US) thickness gauges typically analyse layered materials by utilizing ultrasound reflections between different layers and prior knowledge for the material order within the layered structure. In this study, a dual frequency ultrasound (DFUS) technique is applied to eliminate the effect of overlying layered structure on the measurements of the object of interest without prior knowledge of the order of materials within the multilayered structure. DFUS technique utilizes prior knowledge on US attenuation coefficient and speed at two frequencies in multilayered materials, consisting of two different material types. Then, US reflection from the front (first) and the back (last) surfaces of the multilayered structure is measured using two different US frequencies. No reflections from the internal interfaces are needed. The technique was validated using several elastomer samples and their combinations, measured at 2.25 MHz and 5.0 MHz. DFUS reduced the mean error, induced by the overlying elastomers, in reflection from the object of interest from 103.6 - 289.4% to -15.9 - 5.6% and from 37.5 - 77.5% to -12.0 - 4.9% with 5.0 MHz and 2.25 MHz, respectively. Based on these results, DFUS is a straightforward technique to analyse the multilayered structure without the need for echoes from internal interfaces.