Investigation of Embedded Structures in Media with Unknown Acoustic Properties

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For the nondestructive evaluation of components with ultrasound a priori information about the specimen is necessary. So the time of flight to a defect is measured and, with known sound velocity, it is possible to determine the correct location of the defect. In general, the sound velocity is assumed as known. If it is not known, the sound velocity has to be determined additionally. This can be done, for example, by measuring the time of flight to the backwall with ultrasound and the thickness of the specimen with a caliper gauge. However, this is impossible to realize with single-sided access to the specimen. For determining the size of inclusions, several techniques like the half-value method or the DGS-method (Distance Gain Size) are established. These methods are based on the assumption of (circular) plane reflectors. Therefore, they cannot be applied on the size determination of inclusions with curved surfaces.

This contribution presents new methods for the localization and characterization of inclusions in media with unknown acoustic properties by means of annular arrays. The usage of annular arrays allows the variation of the focus position. By evaluating the signal amplitude as a function of the focus position and the measured time of flight, sound velocity and distance to the reflector can be determined simultaneously [1]. For classifying the inclusions, the directional pattern of the reflected sound field is evaluated. The sound pressure distribution of the reflected sound field at the probe surface mainly depends on the shape of the reflector. Evaluating the amplitude difference between two annular elements allows to classify the reflector shape [2].

These methods are demonstrated on a test specimen with in epoxy resin embedded spheres and circular disc-shaped reflectors with diameters between one and seven wavelengths. The sound velocity of the epoxy resin can be determined with the simultaneous method reaching an accuracy higher than 97%. The amplitude difference method allows to distinguish between spheres and circular disc-shaped reflectors. The same method also enables a non-scanning determination of the size of the circular disc-shaped reflectors, even for dimensions smaller than the width of the sound beam. For the size determination of the spheres, several methods are presented and discussed.

References: