Design, manufacture and characterisation of porous Aluminium and particulate metal composite backing element for high-temperature ultrasonics transducers

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With the emergence of major applications in harsh environments (such as the new generation of nuclear reactors and power plants, steam turbines, aircraft and space rocket engines, etc.), the scientific and industrial community expresses a real need to develop a range of instrumentation dedicated to monitor, control, and check resistance to ageing and damage of a large panel of structure. Ultrasonic transducers are particularly well adapted to address this issue. Up to date, there are no commercial solutions for this type of application and only a few prototypes of ultrasonic transducers exist. A conventional ultrasonic transducer is generally constituted of several layers of material: an active element (piezoelectric disc), a backing element, one or more quarter-wave matching layers, all acoustically coupled. The backing element is of first importance as it controls the sensitivity and broadens bandwidth via its acoustic impedance, increasing the temporal resolution of the reflected echoes. It is therefore important to find new backing materials suitable for the manufacture of high-temperature ultrasonic probes. The aim of this communication is to explore the possibility of using backing material made of porous Aluminium and particulate metal composite, such as Aluminium / Tungsten composites. Backing materials have to absorb all the ultrasonic waves emitted toward the rear face of the piezoelectric element. At the same time, the backing materials should have an acoustic impedance value that enables them to be coupled with a piezoelectric element for suitable non-destructive testing under extreme high-temperature conditions. To complete this backing manufacturing phase, we carry out a simulation of the response of an ultrasonic probe. For a given configuration (piezoelectric element, matching layer, injection medium, etc.), we can observe the theoretical echoes and associated bandwidths for the different substrate materials produced. It was then possible to optimize the manufacturing processes to achieve optimum performances.