Simulation and experimental studies of Gallium Arsenide bulk acoustic wave transducer under lateral field excitation

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A Gallium Arsenide (GaAs) acoustic resonator has been investigated for mass sensing in liquid biodetection applications. Gallium Arsenide presents interesting alternative to quartz crystal concerning resonant sensors[1] thanks to its piezoelectric, acoustic properties, and its common microfabrication processes. GaAs material has the potential to merge most advantages of silicon and quartz. The investigated bulk acoustic wave is excited by lateral field (LFE), which offers the ability to measure liquid mechanical property[2].

The transducer was made using low cost microfabrication techniques. Membrane structure is obtained by wet etching at low temperature; this gives smooth surface roughness for membranes[3].

According to previous studies of our team[4], GaAs (100) plane is used to obtain the highest coupling coefficient along $< 0\ \bar{1}\ 1 >$ or $< 0\ 1\ \bar{1} >$ direction. This coefficient can reach 6.66% for both fast and slow quasi-shear vibration modes. In that case the simulated sensitivity limit is 0.1 ng.Hz^{-1} for a 50 µm thick membrane.

The resonant measurements have experimentally been performed with combined spectrum analyzer and scanning vibrometer devices. Resonators have a resonance frequency around 34.65 MHz for a 50µm thick membrane and 16.62 MHz for a 100µm thick membrane; this is consistent with our predictive models and simulations. Measurements were performed in air and liquids media. And finally a complementary finite element analysis gives us new prospects for increasing sensor sensitivity.

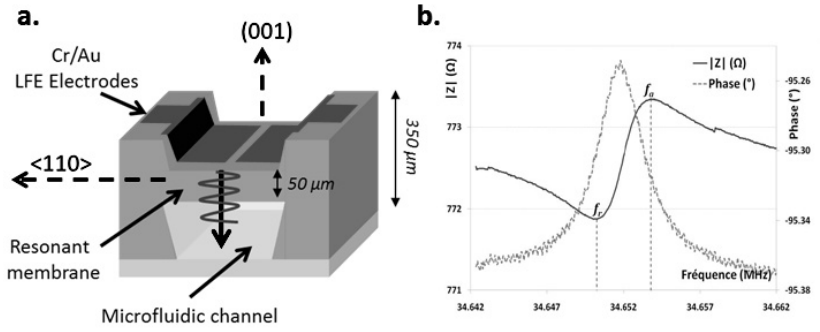

Fig. 1: **(a)** Schematic diagram of GaAs bulk wave sensor; (b) Impedance measurement of the 50µm thick membrane

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