

Langasite and AlN/Sapphire as substrates for Wireless SAW sensor operating in harsh environments

Omar Elmazria, Thierry Aubert, Badreddine Assouar,
Institut Jean Lamour, UMR 7198 CNRS-Nancy University 54506 Vandoeuvre lès Nancy, France

Surface Acoustic Wave (SAW) devices offer very promising solutions in a wide range of applications including physical and chemical sensors. In addition to being small, simple and robust, these devices have the advantage of being passive (batteryless), remotely requestable (wireless) and inexpensive if fabricated on a large scale. The use of SAW devices as passive and wireless sensors allows them to operate in extreme conditions such as those with high levels of radiation, high temperatures up to 1000°C, or electromagnetic interference, in which no other wireless sensor can operate. This is obviously conditioned by the fact that the materials constituting the device can withstand these harsh conditions.

Knowing that the conventional piezoelectric substrates such as quartz or lithium niobate cannot be used at high temperature, R&D is focused on new generation of piezoelectric materials stable in these conditions. Now, there is a large consensus on the use of Langasite ($\text{La}_3\text{Ga}_5\text{SiO}_{14}$ or LGS) for such aim. Indeed, this material has been extensively studied at high temperature showing a very high stability up to its melting temperature at 1473°C and a great resistance to thermal shock treatment. However, it is also characterized by relatively high acoustic propagation losses, which dramatically increase with frequency and temperature, thus limiting the operating frequency below 1 GHz at high temperature. AlN/Sapphire layered structure exhibits, however, a good stability until 900°C and a low propagation loss showing then a good alternative to LGS for high frequency application.

In this lecture, general principle of the SAW sensor in wired and wireless configurations will be developed and a review of our recent works concerning the field of high temperature applications will be presented with specific attention given to the characterisation of materials constituting the SAW device, piezoelectric substrate and metallic electrodes. Both Langasite substrate and AlN/Sapphire structure will be considered.