Diamond-based Surface Acoustic Wave Devices: A Reverse Fabrication Design

Fabrication of diamond-based surface acoustic wave devices typically involves the deposition of piezoelectric layers on a thick diamond film. This project aimed at fabricating diamond-based surface acoustic devices by depositing the diamond films directly on the device dies’ surface. This approach is technologically simpler and less expensive.

**GENERAL MOTIVATION AND OBJECTIVES**
Surface acoustic waves (SAWs) were initially described by Lord Rayleigh in 1885. These waves travel near the surface of solids and have a longitudinal and a vertical shear component that can couple with a media in contact with the surface of the material. In the case of a SAW device, one or more interdigital transducers deposited on a piezoelectric material (such as quartz or lithium niobate) convert SAW waves into electric signals and vice-versa. These devices can be used as filters, delay lines or oscillators.

SAW devices provide significant advantages when compared to other filter technologies (LC filters or bulk quartz crystals) such as reduced size and improved performance and are, for instance, one of the key components responsible for the miniaturization of modern cell phones.

To decrease the size of SAW devices even further, materials with large SAW velocity are required. Diamond has a large Young Modulus (1220 GPa) and a correspondingly high SAW velocity of 100,000 m/s, against 3890 m/s in lithium niobate (127.86° Y-cut). However, diamond is not a piezoelectric material and, as such, the fabrication of diamond-based SAW devices involves the combination of interlayers of different materials, one of which piezoelectric. Current diamond-based SAW devices are usually fabricated through the deposition of a piezoelectric material on the surface of a diamond film. This procedure is expensive and time consuming, since thick diamond substrates have to be deposited and polished before the deposition of the piezoelectric layer takes place.

The objective of this project was to deposit diamond directly on the piezoelectric materials. Following this reverse approach, diamond is deposited directly on the surface of SAW dies, which simplifies the fabrication process to its maximum extent.

**PROJECT PAGE URL**
http://www.avit.pt/jsis/

---

**Fig. 1** Scanning electron microscopic image of diamond film deposited on lithium niobate.

**Fig. 2** Detail of interdigital transducer of uncoated die.