High Throughput Fabrication of SHF SAW Components based on Jet and Flash Imprint Lithography

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The current frequency range for surface acoustic wave SAW based products (filters, resonators and sensors) is limited by the manufacturing process. Deep UV Stepper lithography, which is used for manufacturing of commercial SAW components, has a critical dimension limit of approximately 300 nm, thus limiting commercial production of SAW to the 2.45 GHz band and below. In order to penetrate higher, super high frequency (SHF) bands, a new lithography technique is needed, which can (1) fabricate critical dimensions (CDs) smaller than 300 nm without increasing the fabrication tolerances and (2) can produce large volumes of SAW components with a minimal cost. Electron Beam Lithography (EBL) can fulfill the first criteria. However the throughput is in the order of only one wafer per 10 or more hours, which cannot sustain a viable, cost effective production.

Through the Eurostar NILSAW project we are developing at cost effective manufacturing process targeted towards SHF (SHF > 3 GHz) SAW components using a special type of nanoimprint lithography, namely Jet and Flash Imprint Lithography (J-FIL). J-FIL is a UV step and repeat imprint process, using a 65mm x 65mm, fused Quartz template with an active area of approximately 13 x 13 mm^2, which can achieve a throughput of 1-4 wafers per hour. Furthermore, the same template can pattern 4", 6" and 8" wafers, which promotes quick scaling up of the production when needed. Other unique advantages of the J-FIL process, compared to other nanoimprint techniques, are (1) low imprint force and (2) room temperature. These advantages allow imprinting on fragile substrates such as LiNb and reduces CD distortions due to heating and cooling compared to thermal imprint nanolithography. In figure 1, both images and the frequency response of a 4 GHz sensor fabricated using the develop J-FIL process are shown.

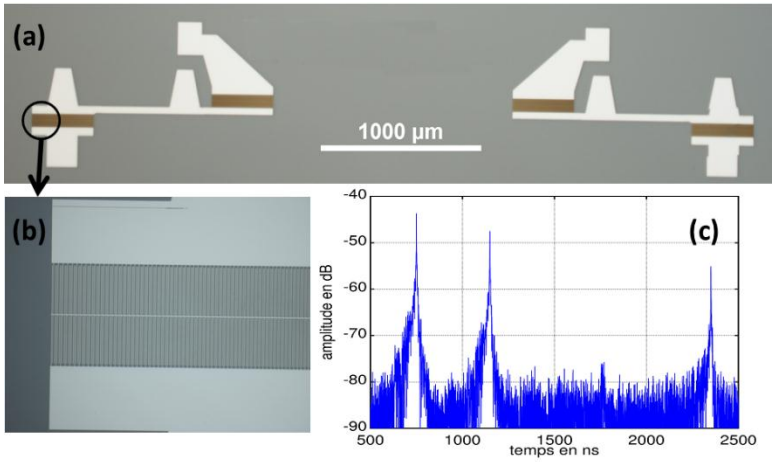

Figure 1.(a) Image of a 4 GHz SAW id-tag/sensor fabricated_ using the J-FIL process (b) a close-up image of the IDT structure, with CDs down to 240nm, far below what is possible with DUV lithography. (d) the electrical response of the 4 GHz SAW sensor which matches nicely with the designed simulations response.

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