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Micron-to-Submicron Cu electroplating in view of Agile-X LSI Chips Fabrication using Open Facility

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Abstract:

The goal of the Agile-X project at UTokyo d.lab, supported by MEXT X-nics, Japan, is to produce custom logic LSI devices (real silicon) in a very short turn-around-time, ideally, in one week. To achieve the goal, d.lab deploys a “structured ASIC” approach. As shown in Fig.1, the transistors and functional building blocks (such as MPU and SRAMs) are pre-fabricated by a mega-foundry, and only adding a couple of metal wiring layers completes an LSI device. The key process is a chip-scale “back end of the line (BEOL)” fabrication with Q-TAT in Takeda Super Clean Room (SCR), Univ. of Tokyo. Both subtractive (etching) process for wider aluminum wirings and additive (electroplating) process for narrower copper (Cu) wirings are under development. This presentation will mainly focus on Cu wiring process optimization thanks to EU-JP international engineers’ cooperation.

First, a dedicated test structure to electrically assess the process performance is designed. Cu BEOL is developed using maskless lithography and electroplating in our SCR. Maskless lithography, such as laser and electron-beam (EB) direct writing on resist film, is a suitable prototyping method in agile and flexible for ever-changing circuit designs. Sub-micron-size fabricated delicate Cu structures on SiO₂/Si substrate by a semi-additive process (SAP) was tested. Cu 50 nm / TiN 10 nm film was deposited on the substrate by magnetron sputtering as the seed layer for electroplating and barrier layer for Cu. Resist-Polymer films (SIPRJ3251, SR7790, ZEP520A, etc.), patterned by laser or EB writing, respectively, were used as masks for Cu electroplating. Figure 2 shows the close-up view of (a) micro- and (b) submicron scale Cu structure on the substrate.

“Under-one-roof” Agile-X LSI fab line in UTokyo d.lab

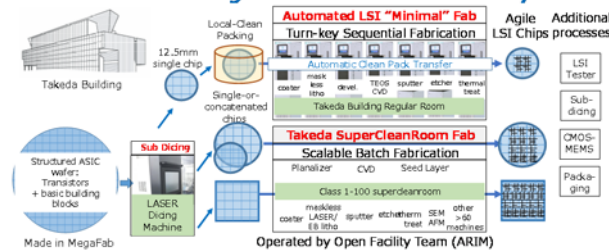


Fig. 1. Agile-X LSI Fabrication Lines

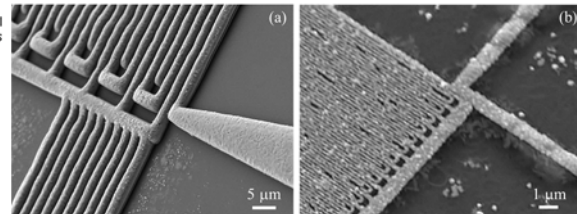


Fig.2 SEM images of (a) micro- and (b) nano-meter scale Cu structure fabricated by Cu electroplating SAP.

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