NEW DEVELOPMENT ON PLASMA-BASED COPPER ETCH AT ROOM TEMPERATURE

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Copper (Cu) is the most popular interconnect material for ULSICs, large-area TFTs, and many optoelectronics. Its high conductivity is critical to signal transmission. It also has high reliability which warranties the product's long lifetime. However, Cu cannot be etched into fine lines using the conventional plasma etching method due to the low volatility of the reaction product. There are many efforts in removing the plasma-Cu reaction product, such as exposing the surface to the high ion bombardment energy or high energy light source. They are not suitable for production requirements with regard to the etch rate, uniformity, and cost. The CMP method was introduced to the industry to solve the problem. Although it is widely used in IC production, there are many issues, such as complicated process steps, poor endpoint control, dishing, high cost, and potential environmental contamination.

A plasma-based Cu etch process was first reported by my group (1,2,3). Instead of in-situ evaporation of the Cu reaction product, the Cu film was converted into a compound layer in a plasma reactor, which was subsequently dissolved in an acid or alkaline solution. The plasma reaction could be carried out at room temperature using a parallel-plate plasma reactor under the conventional etching condition. Hydrochloric acid is available in every fab. The Cu line thin as 0.3 micrometer was demonstrated using this method. The TFT LCD panel was also demonstrated (4).

Originally, chlorine- or bromine-containing gas was used as the feed gas. However, these are corrosive gases that require corrosion-resistant gas delivery line, gas flow control meters, and pumps. Recently, we reported the new process that uses oxygen as the feed gas, which is non-corrosive, environmentally friendly, and low cost with unlimited supply (5). In this talk, the Cu etch process principle will be discussed. The chlorine- and oxygen-based Cu etch results will be compared. Future applications of the room-temperature plasma etched Cu fine lines or patterns will be examined.

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