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Late 1990s

Adoption of shallow trench isolation (STI)

Process Technology ~

STI (shallow trench isolation) is one of the structures of thick oxide film isolation (hereinafter referred to as element isolation) for separating between the element regions on LSI. LOCOS method has long been used for element isolation since the 1970s. The LOCOS method is a method of oxidizing silicon with a Si_3N_4 film as an oxidation mask to form a thick oxide film only in a necessary portion. However, in the LOCOS method, since silicon is also oxidized in the lateral direction, there is a disadvantage that the dimension after oxidation becomes larger even if a pattern is finely formed. An STI structure was proposed to solve this problem.

As the name suggests, STI is a structure in which a shallow trench is formed in an element isolation region and an insulating film is buried in the trench. When RIE is used for groove formation, it does not spread in the lateral direction unlike LOCOS, which is advantageous for miniaturization.

The concept was proposed from the early 1980s, but it could not be practically used due to the lack of flattening and buried oxide film technologies. The real practical use was made possible after CMP was applied for flattening. As for the adoption of this technology in the product, IBM led in the application to 0.35μm DRAM. Among the Japanese manufacturers, Toshiba adopted it for mass production of DRAM in 1996.

The key equipment of STI process are CMP, Si-RIE, buried oxide film deposition and so on. Especially since the buried oxide film requires good filling characteristics into fine grooves and etching resistance after filling, a single wafer CVD oxide film equipment is required. Reflowable oxide films (AMAT, Canon, etc.), anisotropic deposition using HDP (AMAT etc.), coating type oxide films and others appeared, and practical application of STI advanced.

References:

(1) Kurosawa, IEDM81 p384

(2) B. Davari et al., IEDM89, p.61

Version 2019/1/13