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Toshiba Develops New NAND Flash Technology

12 June, 2007

New three dimensional cell array increases density with existing process technology

TOKYO--Toshiba Corporation today announced a new three dimensional memory cell array structure that enhances cell density and data capacity without relying on advances in process technology, and with minimal increase in the chip die size. In the new structure, pillars of stacked memory elements pass vertically through multi-stacked layers of electrode material and utilize shared peripheral circuits. The innovative design is a potential candidate technology for meeting future demand for higher density NAND flash memory.

Typically, advances in memory density reflect advances in process technology. Toshiba's new approach is based on innovations in the stacking process. Existing memory stacking technologies simply stack two-dimensional memory array on top of another, repeating the same set of processes. While this achieves increased memory cell density, it makes the manufacturing process longer and more complex. The new array does increase memory cell density, is easier to fabricate, and does not produce much increase in chip area, as peripheral circuits are shared by several silicon pillars.

Toshiba's cutting edge etching technology drives a through-hole down through a stacked substrate, i.e. a multi-layer sandwich of gate electrodes and insulator films. Pillars of silicon lightly doped with impurities are deposited to fill in the holes. The gate electrode wraps around the silicon pillar at even intervals, and a pre-formed nitride film* for data-retention, set in each joint, functions as a NAND cell.

NAND flash memory functions through batch processing of cells, in large numbers of elements connected in series. Toshiba's new array increases density without increasing chip dimension, as the number of connected elements increases in direct proportion to stack height. For example, a 32-layer stack realizes 10 times the integration of a standard chip formed with the same generation of technology.

Toshiba will further develop this elemental technology to the level where it matches current structures in terms of security and reliability.

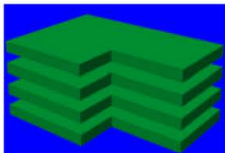
This announcement was presented in the VLSI symposium on June 12.

* Toshiba's new method has a SONOS structure-- silicon-oxide-nitride-oxide- silicon --and the electrical charge is held in the silicon-nitride film, which is formed inside gate holes. Traps are formed to lock the electrical charge inside the silicon-nitride film.

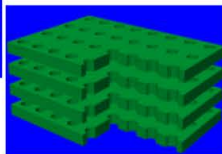
(Annex)

Concept of New Structure

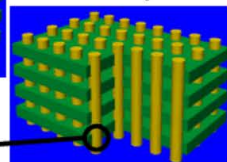
Stacked electrode materials



Vertical through-holes



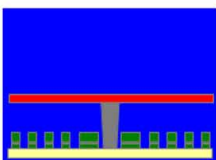
Filled electrode pillars



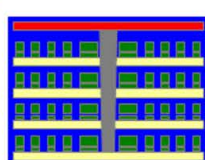
Memory cell

Even if the number of stacks is increased, lithography is only done once, and there is only a small increase in the number of control gate drivers.

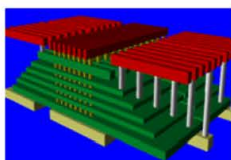
Comparison with previous technologies

Conventional Planar
NAND Flash

Current stacking method



New technology



Current NAND

Vertical plane structure

Stack

Simple multi-stacked structure

Vertically aligned cells

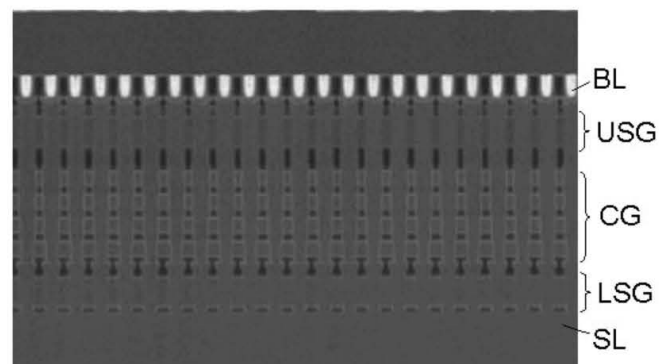
Set the shared select gate in each layer

New NAND Flash memory

The diagram illustrates the evolution of circuit board technology. On the left, a single-layer board is shown with a yellow core and a single yellow circuit layer. A light blue arrow points to the right, where a multi-layer board is shown. This multi-layer board has a red top layer, followed by alternating blue and yellow layers, and a yellow bottom layer. The peripheral circuitry is shown as a complex network of colored lines connecting the layers. A note explains that the same color indicates the layer and its peripheral circuit, and that as technology stacks more layers, the area of core circuits increases. Below the multi-layer board, a note states that as core circuits are shared in the new technology, their area does not show much increase in size.

Note: same color indicates the layer and its peripheral circuit
As the current technology stacks more layers, the area of core circuits increases.

As core circuits are shared in the new technology, their area does not show much increase in size.



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