

CMOS-Technology Compatible Programmable Via using Phase-Change Materials

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A programmable via structure, which is integrated with a heating element and fabricated by CMOS-compatible technology, is proposed. The programmable via, can be shrink to nano-scale size, contains phase-change materials. This structure provides a fast and reliable logic switching property medium with enhanced functionality.

We report a technology of PCM (phase-change material)-based controllable vias offering several advantages, such as spatial compactness, multiple-shot reprogrammability, no need for latches, and immunity from soft errors. This application has no requirement of high switching voltage or high switching power, indicating improved function and lower costs.

The concept of indirect-heating programmable via is described followed: The phase-change material, $\text{Ge}_2\text{Sb}_2\text{Te}_5$ (GST), is used for the programmable via. After integrating with an external heater, this material can be switched between OFF-amorphous and ON-crystalline states. The OFF-amorphous state is resistive

while the ON-crystalline is conductive, as shown in Figs. 1 and 2, respectively.

The operating process can be accomplished by passing current pulses through the external heater. When a high but short current pulse is stressed, a thin region of phase-change materials next to the heater is melted and then quenched to become amorphous. Then the OFF switching is completed. In the ON switching operation, a relatively low but long current pulse is applied through the heater to anneal the amorphous phase-change materials to the crystalline state.

All the technology and fabrication of this device can be completed in a standard CMOS back-end process steps. In addition, from the simulation results, the nano-scale programmable via device is possible and still enjoys excellent performance.

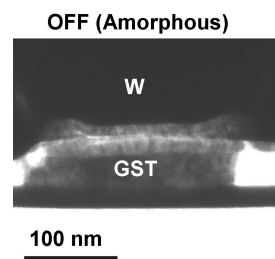


Figure 1 TEM image of OFF state

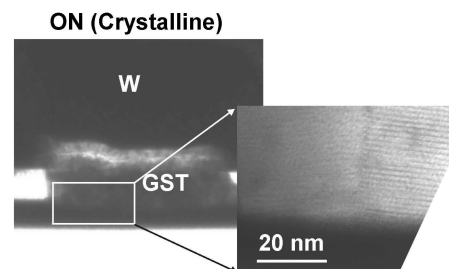


Figure 2 TEM image of ON state