Glassy-polymer Electret Random Access Memory

ECE Ph.D. Seminar

by

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Abstract

Ferroelectric memory devices based on polar polymers are recently the focus of multiple studies. In these devices, the program/erase of memory involves the physical rotation of dipoles by an applied electric field. In the common approach, to obtain fast programming speed the operating temperature needs to be well above the polymer glass transition temperature \(T_g\) because at temperatures below \(T_g\) the dipoles are locked in place. However, fast programming achieved this way means the dipole are easy to rotate, leading to a short retention time.

Here, we demonstrate a radically new ferroelectric memory device concept based on polar polymers with \(T_g\) well above operation temperature. To achieve fast programming, we momentarily elevate the local temperature to well above \(T_g\) while applying a programming electric field. At the normal operation temperature, well below \(T_g\), the dipoles are locked in their position. Neither depolarization field nor READ operation can disturb the memory state. This dual-condition programming (temperature and electric field) with long retention time is demonstrated using a thin-film ferroelectric field effect transistors (FeFET) with CP1 polyimide (\(T_g \approx 265 ^\circ C\)) gate dielectric (15 nm) and a doped polysilicon (15 nm) channel. Retention of the memory states with different programming conditions was studied. This new approach can lead to multi-states memory with extremely long retention times, immune to depolarization fields, while using low cost processing materials that are CMOS compatible and highly scalable.