Description:

When an electric field is applied to an object, the resulting charge separation in the object is referred to as an electric polarization. Although most materials exhibit electric polarization only when an electric field is applied to the material, some materials exhibit electric polarization without an applied electric field (i.e., a spontaneous polarization). Such materials are often referred to as pyroelectric materials. For some pyroelectric materials, the direction of the spontaneous electric polarization can be switched using an applied electric field. Such materials are referred to as ferroelectric materials, and the switching of electric polarization in ferroelectric materials is analogous to the switching of magnetic moments in ferromagnetic materials. In particular, the polarization state of a ferroelectric is a non-volatile parameter that retains its value even if no power is supplied to a device including the ferroelectric. Thus, applications of ferroelectronics to electronic device technology have been under investigation for some time. However, it remains difficult to provide long-term stability of ferroelectric switching in connection with microelectronic devices.

Frederick Joseph Walker, a Research Scientist in the Ahn Lab at Yale University, has discovered that by using existing techniques, he can promote ferroelectric switching in a semiconductor device to a degree that has not yet been accomplished. Ferroelectric semiconductor devices are provided by including a ferroelectric layer in the device that is made of a material that is not ferroelectric in bulk. Such layers can be disposed at interfaces to promote ferroelectric switching in a semiconductor device. Switching of conduction in the semiconductor is effected by the polarization of a mechanically bi-stable material. This material is not ferroelectric in bulk but can be considered to be when the thickness is sufficiently reduced down to a few atomic layers. Devices including such ferroelectric layers are suitable for various applications, such as transistors and memory cells (both volatile and non-volatile).

Field of Application: Semiconductors

Advantages: Higher ferroelectric switching capabilities

Stage of Development: Proof of concept

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