SBT FeRAMs

Out of the many ferroelectric materials available, there are mainly two classes of materials that are currently used for FeRAMs in commercial, industry and radiation-hard applications. One belongs to the conventional pervoskite family (the structure that was explained in the previous section). In this class, Lead Zirconium Titanate (PZT) is the material that is widely being used by industries today. The second one belongs to the layered perovskite family. In this class, Strontium Bismuth Tantalate (SBT) and Bismuth Lanthanum Titanate (BLT) are the two materials that are widely being used by the industries today. From a reliability standpoint, both SBT and BLT based memories offer superior characteristics to that of PZT based memories.

In principle, any of the above mentioned material would be suitable for the ferroelectric memory operation. However, from a reliability stand-point, the layered perovskite family (SBT, BLT) offers superior characteristics over the conventional perovskite (PZT) structure. For example, with PZT, repeated switching cycles is well known to degrade polarization, i.e. the memory window decreases with increased switching cycles. There are alternate ways to improve the fatigue behavior of PZT such as use of oxide electrodes instead of metal electrodes for the capacitor, however, these methods usually compromise other properties of the material such as leakage and/or retention. The reason for polarization degradation with PZT is widely accepted to be due to domain (collection of dipoles) locking due to trapped charges in the bulk of the material which are stabilized due to large amount of oxygen vacancies.

In the layered perovskite structure, in SBT for example, the perovskite unit cells (SrTaO) are interrupted with bismuth oxide layers. Refer to Figure 1 for the structure of SBT where a half unit cell is displayed. This structure has proved to be “fatigue-free” in nature. In SBT, domain locking phenomena also happens, however, at a weaker rate which allows for a self-recovery mechanism. The locking rate is weaker due to a lower oxygen vacancy concentration. This is due to the fact the perovskite unit cells are sandwiched between bismuth oxide layers

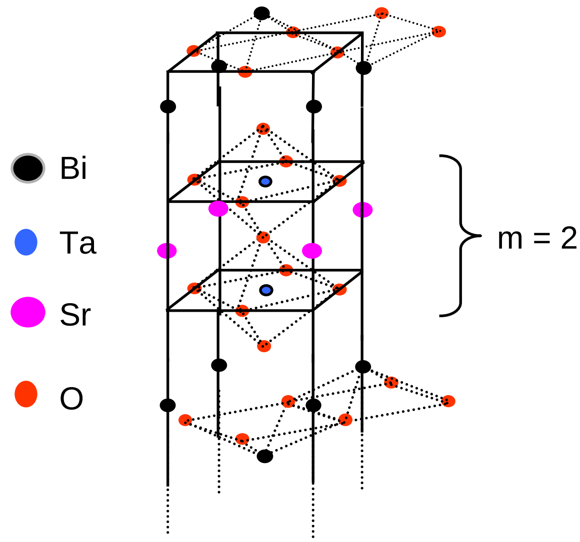

Figure 1. Crystal structure of SBT where half unit cell is shown

where the bismuth oxide layers are indirectly acting as oxide electrodes as shown in Figure 1. This type of crystal structure in layered perovskites is the key reason for its excellent reliability charactersitics (such as fatigue, retention and imprint). Other attractive features of SBT ferroelectric material compared to that of PZT are better imprint characteristics, low voltage/low power operation and scaling potential.