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# Top electrode-dependent retention characteristics of thin-film transistors with carbon nanotube/$(Bi,Nd)_4Ti_3O_{12}$ structure

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## Abstract

Gradient stripe patterns of Single-Walled Carbon Nanotubes (SWCNTs) were fabricated by using the evaporation-induced self-assembly technique. Additionally, the nonvolatile thin-film transistors (TFTs) with SWCNTs and $(Bi,Nd)_4Ti_3O_{12}$ (BNT) insulators were fabricated. The retention characteristics were investigated in Pt/SWCNTs/BNT/$LaNiO_3$ and $LaNiO_3$/SWCNTs/BNT/$LaNiO_3$ structures. Results revealed that $LaNiO_3$/SWCNTs/BNT/$LaNiO_3$ TFTs demonstrate larger on-state current, wider memory window, better fatigue endurance performance and retention characteristics, compared with Pt/SWCNTs/BNT/$LaNiO_3$ TFTs because of the involvement of the oxide conductive electrodes. These results suggest that the SWCNTs/BNT TFTs with $LaNiO_3$ as the electrodes are suitable for next-generation nonvolatile memory devices and integrated circuits.

**Keywords:** Thin-film transistors (TFTs), Single-Walled Carbon Nanotube (SWCNTs), Nonvolatile memory, Ferroelectric film

## 1. Introduction

Recently, Carbon Nanotubes (CNTs) ferroelectric thin-film transistors (TFTs) are

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