Robust Memristive Switching

Tech ID: 34398 / UC Case 2023-945-0

BACKGROUND

Historically, radio frequency and microwave switches have historically relied on either electromechanical switches (which suffer from limited speed and reliability) or solid-state switches such as PIN diodes and field-effect transistors (FETs), both of which require continuous bias current to maintain their states, consuming significant power in modern communication systems. In particular, solid-state switches (PIN diodes and FETs) require continuous DC power to maintain their ON or OFF states, leading to substantial energy consumption particularly problematic for battery-operated devices and large-scale systems like 5G/6G base stations and Internet of Things networks. Emerging non-volatile RF switches based on phase-change materials (PCM) and other memristive devices have shown promise but are constrained by large switching energies, limited resistance modulation ratios (typically < three orders of magnitude), volatile behavior requiring thermal maintenance above transition temperatures, and low endurance.

TECHNOLOGY DESCRIPTION

To help address these challenges in modern switch technologies, researchers at UC Santa Cruz (UCSC) have developed an advanced memristive-based switch device. Compared to typical memristive switches showing 2-3 orders of magnitude, the UCSC device demonstrates exceptional ON-to-OFF resistance ratios of up to five orders of magnitude. The ON-state resistances of ~50 ohms enable natural impedance matching for RF applications. Epitaxially-grown thin films comprising non-stoichiometric copper selenide via molecular beam epitaxy on aluminum oxide (alumina) substrates stabilizes the high-temperature cubic phase at room temperature, enabling robust memristive switching outside the superionic regime and without requiring elevated operating temperatures. Most notably, UCSC research results achieves non-volatile RF switching with measured S-parameter (S21) insertion losses as low as -1.5 dB in the ON state and up to -16 dB in the OFF state across multiple stable resistance states, with state retention after complete removal of the DC bias. This eliminates continuous power consumption and enables zero-static-power RF switching.

APPLICATIONS

- 5G/6G communication system applications
- IoT / wireless sensor applications
- aerospace and defense radar applications

FEATURES/BENEFITS

- 2 to 3 orders of magnitude better switching contrast than typical memristive RF switches.
- Epitaxially-stabilized cubic phase of copper selenide allows for room-temperature memristive operation without thermal management or heating elements.
- Exceptional isolation performance combined with impedance-matched ON-state naturally suited for 50 ohm RF systems.
- Lateral device architecture with multiple stable resistance states permits progressive tuning of RF transmission characteristics across multiple discrete states.

RELATED MATERIALS

CONTACT

Marc Oettinger
marc.oettinger@ucsc.edu
tel: 831-502-0253.

INVENTORS

- Lederman, David

OTHER INFORMATION

KEYWORDS

memristive, switch, switches, epitaxial, switching, microwave, radio-frequency, radio-frequency switch, RF switch, memristor, non-volatile memory, neuromorphic computing, neuromorphic, memristor-based switch

CATEGORIZED AS

- **Communications**
  - Internet
  - Networking
  - Wireless
- **Materials & Chemicals**
  - Storage
  - Thin Films
- **Nanotechnology**
  - Electronics
- **Engineering**
  - Other

RELATED CASES

2023-945-0

Santa Cruz,CA 95064

Fax: 831.459.1658