Simulation of a bistable buckling beam using Electrostatics actuation and Lorentz force.

Angel Gonzalo Soto[1], Shamus Mcnamara[2]
[1]*The University of Texas at El Paso*
[2]*University of Louisville*

The exponential advancement in Integrated Circuits has been supported by CMOS-based memories, such as FLASH memory, for data storage. However, these conventional memory technologies have significant drawbacks, including long write times, as well as potential physical limitations in the near future. To overcome these challenges, emerging memories have garnered considerable attention due to their exponentially lower power consumption and read and write speeds.

This research focuses on the simulation of a mechanical memory non-volatile cell using a bistable buckle beam structure based on MEMS technology. The main goal of this research is to determine how much Lorentz force is required to make an actuation and determine how much time it takes the buckling.

The proposed memory cell achieves two stable positions through voltage-induced electrostatic actuation. The first stable position is attained by applying a voltage to the beam, causing it to actuate upward. To reach the second stable position, a current is applied throughout the beam, resulting in a Lorentz force actuation that causes the beam to buckle up. The capacitance of these two positions can be read using a sense amplifier, allowing the storage of binary numbers '0' and '1'. Titanium tungsten (TiW) has been chosen as the beam material due to its conductivity and stress properties.

The behavior of the MEMS structure will be thoroughly investigated using CoventorWare software for initial simulations. Comprehensive Mechanical, Electrostatics, and Electromechanics analyses will be conducted to assess its performance and characteristics. This research aims to gain valuable insights into whether the proposed mechanical memory exhibits comparable features to conventional memories widely used today. The findings will pave the way for further research and potential advancements in memory technology.

Angel Gonzalo Soto was born in El Paso, Texas but raised in Juarez, Mexico. After completing his foundational courses at El Paso Community College, he transferred to The University of Texas at El Paso. He gained valuable experience by working for nearly one and a half years in a Makerspace at his community college. Last summer, he participated in a fast-paced undergraduate research experience at the University of Iowa. Currently, he is actively engaged in research at his home institution, contributing to the E3C Consortium (The Consortium for Education and Research in Electronics for Extreme Environments). In recognition of his achievements, he has recently been named a 2-to4 scholar.