AzTE Arizona Technology Enterprises

www.azte.com

Molecular Modifications of Metal/Dielectric Interfaces

AzTE Case #M04-036

Inventors

Dr. Sandwip K. Dey

Professor

Department of CME, Arizona State University

Jaydep Goswami

Faculty Research Associate

Department of CME, Arizona State University

Rizaldi Sistiabudi

Student

Department of Bio Engineering, Arizona State University

Diefeng Gu

Student

Department of CME, Arizona State University

Intellectual Property Status

Patent Pending

Contact

Bill Loux

Director of Business Development

Arizona Technology Enterprises, LLC (AzTE)

480.884.1996 main

480.884.1992 desk

Email: bloux@azte.com

Background

In the field of biochemical deposition, the use of organic molecules to modify the interface between metal and high-permittivity (K) material is a recent development with a wealth of applications. Generally, there have been two main approaches to molecular control over electronic device properties: 1) control of the electrical potential at the interface (electrostatics), 2) control of charge transport across the interface (electron dynamics). For purposes of stability and reliability, the electrostatic approach may be more favorable. Methods, while complicated, do exist for tuning complementary metal-oxide-semiconductor (CMOS) devices integrating high permittivity (K) gate dielectric films; however, effective integration of such materials into future devices, specifically dual-metal MOSFETs, will require alternative solutions to tuning specific metals. Meanwhile, an alternative to the use of dual metals in CMOS with high K dielectrics would also be desirable.

Invention Description

Researchers at Arizona State University have developed such an alternative method to tune the properties of solid surfaces through deposition of self-assembled monolayers (SAM) or organic molecules yielding hybrid, multifunctional systems that combine both the molecular and non-molecular worlds. Specifically, the method applies systematic substitutions of different functional groups within an organic molecule to tailor both the magnitude of the dipole moment and its direction on a solid surface. Subsequently, a molecularly based system can potentially tune the electrical characteristics (e.g. equivalent oxide thickness (EOT), flat band voltage (V_{FB}), work-function, and leakage current) of CMOS gate-stacks with a simplified production technology.

Potential Applications

- **Microelectronics** (e.g. CMOS devices)
- **Optoelectronics**
- **Molecular Electronics and Bio-Nanodevices**

Benefits and Advantages

- **Eliminates the Use of Dual Metal Gates in CMOS –** alleviates complications from deposition/etching and issues of yield, etc.
- **Significantly Reduces Cost** – reduces cost of metallization in advanced semiconductor devices by simplifying the technology
- **Enhanced Tuning Capability** – potential to tune EOT, V_{FB}, work-function, and leakage current
- **Novel Bio-sensor Fabrication** – soft-mode hardening may allow for changes to eigen-frequency of the transverse optical phonon mode