US-Africa Initiative Workshop at APS March Meeting

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Lecturer

Topic: Microscopic control of SiGe/high-κ oxide gate stack for p-MOSFET hole qubits

Research

My research interest involve the investigation of semiconductor materials (e.g Full and half-Heusler alloys) properties for photovoltaic, thermoelectric and spintronic devices applications using density functional theory. Currently, I am investigating the properties of Si-SiGe-Ge alloys within the activity of the EU project iQubits ”www.iqubits.eu”.

Collaboration

I have worked in collaboration as a postdoc in the group of Dr. Arrigo Calzolari at CNR-NANO, Modena. http://amuse.nano.cnr.it/

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Microscopic control of SiGe/high-κoxide gate stack for p-MOSFET hole qubits

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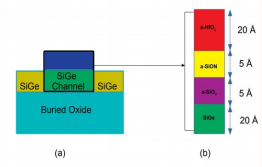
INRODUCTION

The potential of silicon-based electron-spin and hole-spin coupled quantum-dot qubits as material for commer-cial complementary metal oxide semiconductor (CMOS)technology have generated a lot of interest due totheir greater significant of record coherence times andfidelity. Despite of these characteristics, their oper-ation has been limited to temperatures below 100 mK be-cause of the low confinement and coupling energies.Getting qubit with higher confinement and coupling en-ergies, with spin resonance in the upper mm-wave re-gion will give room for higher temperature peration.Therefore, many channel materials such as Si-channel n-MOSFETs(electron-spin qubit) and SiGe-channel p-MOSFETs(hole-spin qubit) are now being investigatedfor the realization of quantum-dot qubits with higher temperature and fidelity for quantum computing. Thus,the control and the stability of the resulting qubits rely on the control and the stability of the underlying MOSFETs device.

METHODOLOGY

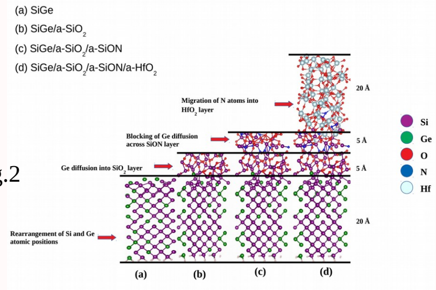
Fig1



The semiconductor channel is modeled through a periodic supercell including a $Si_{0.75}Ge_{0.25}$(001) surface (i.e. 128 atoms) with a (2x2) lateral periodicity of dimension (11.15 x11.15)Å^2 and 11.15Å of thickness, obtained through the geometry optimization of the (2x2x2) cubic supercell. A 15Å thick layer of vacuum was added to prevent interactions between periodically repeated slab replicas. Bottom layer was passivated with Hydrogen(H).

STRUCTURAL OPTIMIZATION

Fig.2



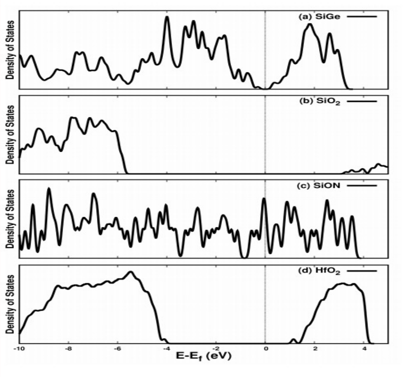


Fig.3

RESULTS AND DISCUSSIONS

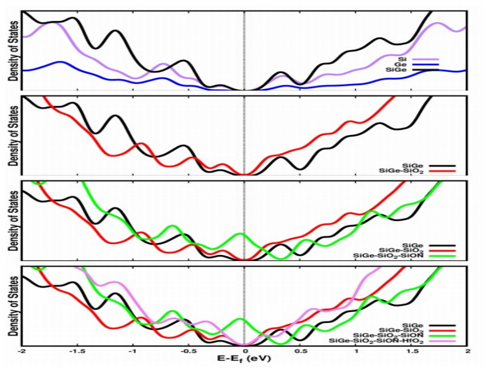


Fig.4

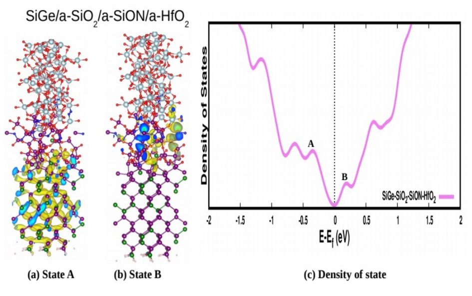


Fig.5