Charge Directed Chemical Self-Assembly on CeO_2/Si Heterojunctions

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We report the lithographic charging of the surface of CeO_2/Si heterostructures on scales less than 100nm and speculate on the implications of these very recently observed phenomena on the production of chemically specific MOSFET's in silicon. Silicon is by far the most widely employed semiconductor in modern electronics. Advanced digital signal processing is dominated by the wonderful properties of this material. As a result, we have been researching ways of producing nanostructures in silicon. Presently, silicon has limited applicability for nanostructures because of the lack of a crystalline wide bandgap companion for the production of heterojunctions. We have recently shown that the Si/CeO_2/Si couple could be the basis for a fully functional heterostructure technology. These technologies include various quantum devices such as resonant tunneling devices, tunnel switched diodes, standard MOSFET's as well as three dimensional electronics.
We report recent experiments in which we have locally charged CeO_2 layers on silicon. By applying large charging voltages to an atomic force microscope tip and reducing the tip to sample separation to 3-5 nm, we could write very long lived islands of both positive and negative charge 20 to 150 nm in radius. These long lived charged islands could be functionalized with polar molecules as part of the fabrication of biosensors or biochips on silicon electronics since this technique would allow us to precisely attach molecules directly on fully functional transistors. While this effort is only beginning, one might speculate that it could lead to very sensitive test for cancer or for life in remote planetary explorations.