SEMICONDUCTOR INTERFACES: FORMATION AND PROPERTIES pdf

1: Wetting Layer and Formation of Metal - Semiconductor Interface

Get this from a library! Semiconductor Interfaces: Formation and Properties. [Guy Lay; J Derrien; Nino Boccara] -- The trend towards miniaturization of microelectronic devices and the search for exotic new optoelectronic devices based on multilayers confer a crucial role upon semiconductor interfaces.

Soubatch, Ulrich Starke Abstract: The sample is initially prepared by hydrogen etching before loading into the ultra-high vacuum system. The sample is then out-gassed to remove oxygen from the surface. The changes between these phases are clearly demonstrated by the LEED spot intensities. Choyke, Ulrich Starke Abstract: After initial hydrogen etching, the samples were prepared by Si deposition and annealing in ultra-high vacuum UHV. After further annealing the fractional order LEED spots vanish and a 1x1 pattern develops. These highly linear and equidistant chains represent a self-assembled well-ordered pattern of nanowires developing due to the intrinsic structure of the 4H-SiC surface. The paper presents metrology of the growth and characterization of 3d metal monolayer films on silicon. EELS analysis of plasmon peaks during the layer-by-layer growth of Co films on Si demonstrate that thickness measurement of the monolayer films is possible on base of spectra decomposition with interface and film plasmon peak extracting. Results of the resistivity measurement of Co films on Si with different state of the surface correlate with growth mechanism of the films on AES data. AFM-pictures show replication of step surface relief versus the thickness demonstrating growth of the smooth Fe nanofilm on Si Gheriani, Rachid Halimi Abstract: Titanium carbides are well known materials with great scientific and technological interest. The applications of these materials take advantage of the fact that they are very hard, refractory and that they have metallic properties. The growth of micro-hardness is due to the diffusion of the carbon, and to the formation of titanium carbide. However, the decrease of micro-hardness is associated with the diffusion of iron and the formation of iron oxide Fe_2O_3. At higher temperatures, we note the formation of titanium dioxide TiO_2. Silicide sequential phase formation during tens-of-nanometer-thick metallic film reaction on Si substrate has been extensively studied. Nevertheless, the reasons of sequential phase formation are still under debate, and have been poorly studied at the atomic scale. These predictions are supported by experimental observations:

2: Semiconductor - Wikipedia

This book is a collection of lectures that were given at the International Winter School on Semiconductor Interfaces: Formation and Properties held at the Centre de Physique des Rouches from 24 February to 6 March,

Silicon crystals are the most common semiconducting materials used in microelectronics and photovoltaics. A large number of elements and compounds have semiconducting properties, including: Silicon and germanium are used here effectively because they have 4 valence electrons in their outermost shell which gives them the ability to gain or lose electrons equally at the same time. Binary compounds, particularly between elements in Groups 13 and 15, such as gallium arsenide , Groups 12 and 16, groups 14 and 16, and between different group 14 elements, e. Certain ternary compounds, oxides and alloys. Organic semiconductors , made of organic compounds. Most common semiconducting materials are crystalline solids, but amorphous and liquid semiconductors are also known. These include hydrogenated amorphous silicon and mixtures of arsenic , selenium and tellurium in a variety of proportions. These compounds share with better known semiconductors the properties of intermediate conductivity and a rapid variation of conductivity with temperature, as well as occasional negative resistance. Such disordered materials lack the rigid crystalline structure of conventional semiconductors such as silicon. They are generally used in thin film structures, which do not require material of higher electronic quality, being relatively insensitive to impurities and radiation damage. Semiconductors for ICs are mass-produced. To create an ideal semiconducting material, chemical purity is paramount. Any small imperfection can have a drastic effect on how the semiconducting material behaves due to the scale at which the materials are used. Crystalline faults are a major cause of defective semiconductor devices. The larger the crystal, the more difficult it is to achieve the necessary perfection. There is a combination of processes that is used to prepare semiconducting materials for ICs. One process is called thermal oxidation , which forms silicon dioxide on the surface of the silicon. This is used as a gate insulator and field oxide. Other processes are called photomasks and photolithography. This process is what creates the patterns on the circuity in the integrated circuit. Ultraviolet light is used along with a photoresist layer to create a chemical change that generates the patterns for the circuit. The part of the silicon that was not covered by the photoresist layer from the previous step can now be etched. The main process typically used today is called plasma etching. Plasma etching usually involves an etch gas pumped in a low-pressure chamber to create plasma. A common etch gas is chlorofluorocarbon , or more commonly known Freon. A high radio-frequency voltage between the cathode and anode is what creates the plasma in the chamber. The silicon wafer is located on the cathode, which causes it to be hit by the positively charged ions that are released from the plasma. The end result is silicon that is etched anisotropically. This is the process that gives the semiconducting material its desired semiconducting properties. It is also known as doping. The process introduces an impure atom to the system, which creates the p-n junction. In order to get the impure atoms embedded in the silicon wafer, the wafer is first put in a 1, degree Celsius chamber. The atoms are injected in and eventually diffuse with the silicon. After the process is completed and the silicon has reached room temperature, the doping process is done and the semiconducting material is ready to be used in an integrated circuit. Electronic band structure and Electrical conduction Filling of the electronic states in various types of materials at equilibrium. Here, height is energy while width is the density of available states for a certain energy in the material listed. In metals and semimetals the Fermi level EF lies inside at least one band. In insulators and semiconductors the Fermi level is inside a band gap ; however, in semiconductors the bands are near enough to the Fermi level to be thermally populated with electrons or holes. These states are associated with the electronic band structure of the material. Electrical conductivity arises due to the presence of electrons in states that are delocalized extending through the material , however in order to transport electrons a state must be partially filled, containing an electron only part of the time. The energies of these quantum states are critical, since a state is partially filled only if its energy is near the Fermi level see Fermiâ€”Dirac statistics. High conductivity in a material comes from it having many partially filled states and much state delocalization. Metals are good electrical conductors and have many partially filled states with energies near their Fermi level. Insulators , by contrast, have few partially filled states, their Fermi levels sit within band gaps with few energy states to occupy. Importantly, an insulator can be made to conduct by increasing its temperature: An intrinsic semiconductor has a band gap that is smaller than that of an insulator and at room temperature significant numbers of electrons can be excited to cross the band gap. However, one important feature of semiconductors and some insulators, known as semi-insulators is that their conductivity can be increased and controlled by doping with impurities and gating with electric fields. Doping and gating move either the conduction or valence band much closer to the Fermi level, and greatly increase the number of partially filled states. Some wider-band gap semiconductor materials are sometimes referred to as semi-insulators. When undoped, these have electrical conductivity nearer to that of electrical insulators, however they can be doped making them as useful as semiconductors. Semi-insulators find niche applications in micro-electronics, such as substrates for HEMT. An example of a common semi-insulator is gallium arsenide. Charge carriers electrons and holes [edit] Main article: Electron hole The partial filling of the states at the bottom of the conduction band can be understood as adding electrons to that band. The electrons do not stay indefinitely due to the natural thermal recombination but they can move around for some time. The actual concentration of electrons is typically very dilute, and so unlike in metals it is possible to think of the electrons in the conduction band of a semiconductor as a sort of classical ideal gas , where the electrons fly around freely without being subject to the Pauli exclusion principle. In most semiconductors the conduction bands have a parabolic dispersion relation , and so these electrons respond to forces electric field, magnetic field, etc. For partial filling at the top of the valence band, it is helpful to introduce the concept of an electron hole. Although the electrons in the valence band are always moving around, a completely full valence band is inert, not conducting any current. If an electron is taken out of the valence band, then the trajectory that the electron would normally have taken is now missing its charge. For the purposes of electric current, this combination of the full valence band, minus the electron, can be converted into a picture of a completely empty band containing a positively charged particle that moves in the same way as the electron. Combined with the negative effective mass of the electrons at the top of the valence band, we arrive at a picture of a positively charged particle that responds to electric and magnetic fields just as a normal positively charged particle would do in vacuum, again with some positive effective mass. Carrier generation and recombination[edit] Main article: Carrier generation and recombination When ionizing radiation strikes a semiconductor, it may excite an electron out of its energy level and consequently leave a hole. This process is known as electronâ€”hole pair generation. Electron-hole pairs are constantly generated from thermal energy as well, in the absence of any external energy source. Electron-hole pairs are also apt to recombine. Conservation of energy demands that these recombination events, in which an electron loses an amount of energy larger than the band gap , be accompanied by the emission of thermal energy in the form of phonons or radiation in the form of photons. In some states, the generation and recombination of electronâ€”hole pairs are in equipoise. The number of electron-hole pairs in the steady state at a given temperature is determined by quantum statistical mechanics. The precise quantum mechanical mechanisms of generation and recombination are governed by conservation of energy and conservation of momentum. As the probability that electrons and holes meet together is proportional to the product of their numbers, the product is in steady state nearly constant at a given temperature, providing that there is no significant electric field which might "flush" carriers of both types, or move them from neighbour regions containing more of them to meet together or externally driven pair generation. The probability of meeting is increased by carrier trapsâ€”impurities or dislocations which can trap an electron or hole and hold it until a pair is completed. Such carrier traps are sometimes purposely added to reduce the time needed to reach the steady state.

3: Metalâ€“semiconductor junction - Wikipedia

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These would either be induced during the direct chemical bonding of the metal and semiconductor metal-induced gap states or be already present in the semiconductorâ€”vacuum surface surface states. These highly dense surface states would be able to absorb a large quantity of charge donated from the metal, effectively shielding the semiconductor from the details of the metal. In the case of germanium, germanium nitride has been used [7] History[edit] The rectification property of metalâ€”semiconductor contacts was discovered by Ferdinand Braun in using mercury metal contacted with copper and iron sulfide semiconductors. This patent was awarded in Wikisource has original text related to this article: JC Bose patent G. Pickard received a patent in on a point-contact rectifier using silicon. In , George W. Pierce published a paper in Physical Review showing rectification properties of diodes made by sputtering many metals on many semiconductors. The first large area rectifier appeared around which consisted of a copper I oxide semiconductor thermally grown on a copper substrate. Subsequently, selenium films were evaporated onto large metal substrates to form the rectifying diodes. These selenium rectifiers were used and are still used to convert alternating current to direct current in electrical power applications. During â€”, diodes consisting of a pointed tungsten metal wire in contact with a silicon crystal base, were fabricated in laboratories to detect microwaves in the UHF range. A World War II program to manufacture high-purity silicon as the crystal base for the point-contact rectifier was suggested by Frederick Seitz in and successfully undertaken by the Experimental Station of the E. I du Pont de Nemours Company. The first theory that predicted the correct direction of rectification of the metalâ€”semiconductor junction was given by Nevill Mott in He found the solution for both the diffusion and drift currents of the majority carriers through the semiconductor surface space charge layer which has been known since about as the Mott barrier. This changed the constant electric field assumed by Mott to a linearly decaying electric field. This semiconductor space-charge layer under the metal is known as the Schottky barrier. A similar theory was also proposed by Davydov in The correct theory was developed by Hans Bethe and reported by him in a M. Radiation Laboratory Report dated November 23, Thus, the appropriate name for the metalâ€”semiconductor diode should be the Bethe diode, instead of the Schottky diode , since the Schottky theory does not predict the modern metalâ€”semiconductor diode characteristics correctly. Depending on the doping type and density in the semiconductor, the droplet spreading depends on the magnitude and sign of the voltage applied to the mercury droplet.

4: Semiconductor Interfaces: Formation and Properties : Nino Boccara :

motion at interfaces during the initial stages of formation. This result for Ge growth on () surfaces of GaAs demonstrates the importance of surface energy in determining the ultimate configuration of semiconductor interfaces.

5: On the formation of semiconductor interfaces - IOPscience

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