CHEMISTRY AND PHYSICS OF INTERFACES. pdf

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The text reflects the fact that the physics and chemistry of surfaces is a diverse area of research that involves classical scientific and engineering disciplines. As such, it discusses fundamental subjects, such as thermodynamics of interfaces, as well as applied topics including wetting, friction, and lubrication.

After receiving his PhD in he went as a postdoc to Santa Barbara, California, and learned using the newly developed atomic force microscope. In he became associate professor at the University of Mainz. Three years later he moved to Siegen to become full professor for physical chemistry. After receiving his PhD in physical chemistry in , he went as a postdoc to Santa Barbara, California working on physicochemical aspects of myelin and lung surfactant. Back in Mainz he investigated nanostructured lipopolymer films. From - he did one and a half years of postdoctoral research at the University of Mainz in the group of Hans-Jurgen Butt. The general yet comprehensive introduction to this field focuses on the essential concepts rather than specific details, on intuitive understanding rather than learning facts. Manifold high-end applications from surface technology, biotechnology, or microelectronics are used to illustrate the basic concepts. In this new edition, topics such as depletion forces, surface modification by plasma polymerization, principles of lithography, or microemulsions as templates in materials Sciences have been added. The number and variety of exercises has been increased. The book is well worth a place on the shelf of material scientists and engineers involved in surface phenomena. It is very didactic, clear, concise, and well-organized. Scince he is working on model systems for microsystem technology in the group of Hans-J? From - he did one and a half years of postdoctoral research at the University of Mainz in the group of Hans-J? In , he rejoined the group of HansJ? The electric double layer. Effects at charged interfaces. Contact angle phenomena and wetting. Friction, lubrication, and wear. Surfactants, micelles, emulsions, and foams. Thin films on surfaces of liquids. Analysis of diffraction patterns.

CHEMISTRY AND PHYSICS OF INTERFACES. pdf

2: Physics and Chemistry of Interfaces : Hans-JÃ¼rgen Butt :

The third edition of this excellent textbook for advanced students in material science, chemistry, physics, biology, engineering, or for researchers needing background knowledge in surface and interface science.

Editor s Bio Summary This book covers a selection of recent research studies and new developments in physics and chemistry in micro and nanoscale materials. It brings together research contributions from eminent experts in the field from both academic and industry, providing the latest developments in advanced materials chemical domains. Massinga Jr, and Walter W. Zaikov Nanohydrodynamics and Liquid-Solid Interfaces: A Comprehensive Review, A. He taught various courses in chemical engineering, and his main area has been teaching the capstone process design as well as supervising industrial internship projects. He is a member of several professional organizations, including the American Institute of Chemical Engineers. He is on the international editorial review board of the International Journal of Chemoinformatics and Chemical Engineering and is an editorial member of the International of Journal of Advanced Packaging Technology. He has published many articles and presented at many professional conferences. She is a well-known scientist in the field of organic chemistry, chemistry and physics of polymers, and composites and nanocomposites. She has published 10 books and volumes and about original papers and reviews. She was the vice-director of the Institute of Polymer Sciences and Technology from Her research interests focus on the synthesis and assembly of hybrid nanomaterials, nanoplasmonics, and their uses in nanobiotechnology applications, such as bioimaging, drug delivery, therapy, and biosensing. He is the author and editor of 65 books as well as published papers in various journals and conference proceedings. Haghi has received several grants, consulted for a number of major corporations, and is a frequent speaker to national and international audiences. Since , he served as a professor at several universities. He is currently editor-in-chief of the International Journal of Chemoinformatics and Chemical Engineering and Polymers Research Journal and on the editorial boards of many international journals. Zaikov, DSc, is head of the polymer division at the N. He is also a prolific author, researcher, and lecturer. He has received several awards for his work, including the Russian Federation Scholarship for Outstanding Scientists. He has been a member of many professional organizations and on the editorial boards of many international science journals.

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3: physics and chemistry of interfaces | Download eBook pdf, epub, tuebl, mobi

It addresses (1) advanced students of engineering, chemistry, physics, biology, and related subjects and (2) scientists in academia or industry, who are not yet specialists in surface science but want to get a solid background knowledge of the subject.

If we consider the solid, liquid, and gas phase we immediately get three combinations of interfaces: These interfaces are also called surfaces. Interface is, however, a more general term than surface. Interfaces can also separate two immiscible liquids such as water and oil. These are called liquidâ€"liquid interfaces. Solidâ€"solid interfaces separate two solid phases. They are important for the mechanical behavior of solid materials. Gasâ€"gas interfaces do not exist because gases mix. Often interfaces and colloids are discussed together. He applied it to materials which seemed to dissolve but were not able to penetrate a membrane, such as albumin, starch, and dextrin. A dispersion is a two-phase system which is uniform on the macroscopic but not on the microscopic scale. It consists of grains or droplets of one phase in a matrix of the other phase. Different kinds of dispersions can be formed. Most of them have important applications and have special names Table 1. In some cases this distinction is obvious. Nobody will, for instance, mix up fog with a foam although in both cases a liquid and a gas are involved. In other cases the distinction between continuous and inner phase cannot be made because both phases might form connected networks. Some emulsions for instance tend to form a bicontinuous phase, in which both phases form an interwoven network. Schematic of a dispersion. Colloids and interfaces are intimately related. Gravity is negligible in the 1 Thomas Graham, â€" British chemist, professor in Glasgow and London. A system which is dominated by surface effects is shown on the left side of the cover. While sedimenting they formed fractal aggregates due to attractive van der Waals forces. On the bottom they were collected. These aggregates are stable for weeks and months and even shaking does not change their structure. Gravity and inertia, which rule the macroscopic world, are not able to bend down the particle chains. Surface forces are much stronger. In the recent literature the terms nanoparticles and nanosystems are used, in analogy to colloid and colloidal systems. Why is there an interest in interfaces and colloids? First, for a better understanding of natural processes. For example, in biology the surface tension of water allows to form lipid membranes. This is a prerequisite for the formation of compartments and thus any form of life. In geology the swelling of clay or soil in the presence of water is an important process. The formation of clouds and rain due to nucleation of water around small dust particles is dominated by surface effects. Many foods, like butter, milk, or mayonnaise are emulsions. Their properties are determined by the liquidâ€"liquid interface. Second, there are many technological applications. Washing and detergency are examples which any person encounters every day. In tribology, wear is reduced by lubrication which again is a surface phenomenon. Introductory books on interface science are Refs. For a deeper understanding we recommend the series of books of Lyklema [7â€"9]. Density of a liquid versus the coordinate normal to its surface: Tridecane is practically not volatile. For this reason the density in the vapor phase is negligible. Another possible parameter is the orientation of the molecules. This orientation fades with increasing distance from the surface. At a distance of 1â€"2 nm the molecules are again randomly oriented. Parte 1 de 6.

4: Physics and Chemistry of Interfaces : Michael Kappl :

Description The third edition of this excellent textbook for advanced students in material science, chemistry, physics, biology, engineering, or for researchers needing background knowledge in surface and interface science.

Scope[edit] Physics and chemistry may overlap when the system under study involves matter composed of electrons and nuclei made of protons and neutrons. On the other hand, chemistry is not concerned with other forms of matter such as quarks , mu and tau leptons and dark matter. Although fundamental laws that govern the behavior of matter apply both in chemistry and physics, the disciplines of physics and chemistry are distinct. Physics is concerned with nature from a very large scale the entire universe down to a very small scale subatomic particles. All physical phenomena that are measurable follow some behavior that is in accordance with the most basic principles studied in physics. Physics also deals with the basic principles that explain matter and energy, and may study aspects of atomic matter by following concepts derived from the most fundamental principles. Chemistry focuses on how substances interact with each other and with energy for example heat and light. Chemistry also studies the properties of matter at a larger scale for example, astrochemistry and the reactions of matter at a larger scale for example, technical chemistry , but typically, explanations and predictions are related back to the underlying atomic structure, giving more emphasis on the methods for the identification of molecules and their mechanisms of transformation than any other science. Approach[edit] Although both physics and chemistry are concerned with matter and its interaction with energy, the two disciplines differ in approach. In physics, it is typical to abstract from the specific type of matter, and to focus on the common properties of many different materials. Chemistry, on the other hand, focuses on what compounds are present in a sample, and explores how changing the structure of molecules will change their reactivity and their physical properties. Physics can be divided into experimental and theoretical physics. Historically, theoretical physics has correctly predicted phenomena that were out of experimental reach at the time, and could be verified only after experimental techniques caught up. Training[edit] In a typical undergraduate program for physics majors, required courses are in the sub-disciplines of physics, with additional required courses in mathematics. In a typical undergraduate program for chemistry majors, emphasis is placed on laboratory classes and understanding and applying models describing chemical bonds and molecular structure. Emphasis is also placed in the methods for analysis and the formulas and equations used when considering the chemical transformation. Students take courses in math, physics, chemistry, and often biochemistry. Between the two programs of study, there is a large area of overlap calculus , introductory physics, quantum mechanics , thermodynamics. However, physics places a larger emphasis on fundamental theory with its deep mathematical treatment while chemistry places more emphasis in combining the most important mathematical definitions of the theory with the approach of the molecular models. Laboratory skills may differ in both programs, as students may be involved in different technologies, depending on the program and the institution of higher education for example, a chemistry student may spend more laboratory time dealing with glassware for distillation and purification or on a form of chromatography -spectroscopy instrument, while a physics student may spend much more time dealing with a laser and non-linear optics technology or some complex electrical circuit. Careers in chemistry and physics[edit] According to Bureau of Labor Statistics United States Department of Labor , there are 80, chemists and 17, physicists working in the United States as of May Chemistry is the only science that has an entire industry, the chemical industry , named after it, and many chemists work in this industry, in research and development , production, training, or management. Other industries employing chemists include the petroleum , pharmaceutical, and food industry. While there is no industry named after physics, many industries have grown out of physics research, most notably the semiconductor and electronics industry. Physicists are also employed outside of science, for example in finance, because of their training in modeling complex systems.

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5: Chemistry and physics of interfaces. (edition) | Open Library

Chemistry and Physics at Interfaces Chemical transformations and physical phenomena at gas, liquid and solid interfaces lie at the heart of today's energy technologies. They underpin ORNL's research strategies to deliver scientific discoveries and technical breakthroughs that will accelerate the development and deployment of solutions in.

Two spherical particles with liquid meniscus. It does not depend on the actual radius of curvature of the liquid surface nor on the vapor pressure! At the same time the Laplace pressure increases by the same amount. A quartz sphere hangs on a second similar sphere. Some water vapor is in the room which leads to a capillary force. Small particles are held by the capillary force, large particles fall down due to the dominating gravitational force. Beyond which particle radius is gravity strong enough to separate the two spheres? Two particles with rough surfaces in contact. In reality the capillary force is often much smaller than the calculated value. This can be explained by the roughness of the surfaces. The particle surfaces are usually rough and touch only at some points. Capillary condensation takes place only at these points, as illustrated in Fig. A calculation of the distance dependence of the capillary force and of adhesion can be found in Refs. The formation of a new phase in the absence of an external surface is called homogeneous nucleation. These clusters grow due to the condensation of other molecules. In addition, they aggregate to form larger clusters. Finally macroscopic drops form. In most practical situations we encounter heterogeneous nucleation, where a vapor condenses onto a surface such as a dust particle. A well known example of heterogeneous nucleation is the formation of bubbles when pouring sparkling water or if you prefer beer into a glass. Bubbles nucleate at the glass surface, grow in size and eventually rise. Here we only discuss homogeneous nucleation. Though it is less common, the mathematical treatment and the concepts developed are important and are also used for other applications. The classical theory of homogeneous nucleation was developed around â€" [26, 27]. In order to describe nucleation, we calculate the change in the Gibbs free energy for the condensation of n moles vapor at a vapor pressure P , into a drop. Please note that n is much smaller than one. Keep also in mind that in this chapter, P is not the total pressure. The total pressure might be higher than the vapor pressure due to the presence of other gases. Here, GL is the Gibbs free energy of the liquid drop and GV is the Gibbs free energy of the corresponding number of molecules in the vapor phase. To calculate GL we use the fact that it is equal to the Gibbs free energy of a hypothetical vapor, which is in equilibrium with the liquid drop. In addition, the drop has a surface tension which has to be considered. The Kelvin equation applies to systems in thermodynamic equilibrium. As an example, Fig. Supersaturation is the actual vapor pressure P divided by the vapor pressure P0 of a vapor, which is in equilibrium with a liquid having a planar surface. This corresponds approximately to 70 molecules. How does nucleation proceed? In a vapor there are always a certain number of clusters. Most of them are very small and consist only of a few molecules. Others are a little larger. When the actual partial pressure P becomes higher than the equilibrium vapor pressure P0 , large clusters occur more frequently. A 22 2 Liquid surfaces Figure 2. Change of Gibbs free energy for the condensation of vapor to a drop of a certain radius. Classical nucleation theory is the basis for understanding condensation and it predicts the dependencies correctly. Unfortunately, quantitatively the predictions often do not agree with experimental results [28, 29]. Theory predicts too low nucleation rates at low temperatures. At high temperatures the calculated rates are too high. Empirical correction functions can be used and then very good agreement is achieved [30]. General overviews are Refs. Experimentally nucleation rates can be determined in expansion chambers [35]. The vapor is expanded in a fast and practically adiabatic process. Then it cools down. Since at low temperatures, the equilibrium vapor pressure is much lower, supersaturation is reached. Partially, this is compensated for by the pressure reduction during the expansion, but the temperature effect dominates. The density of nuclei can be measured by light scattering. The nucleation of water is analysed in an expansion chamber. In this process it cools down to K. At K the equilibrium vapor pressure is Pa. What is the nucleation rate? Inserting these values into Eq. One example is the formation of bubbles in champagne [37]. At the end of the fermentation process, the CO_2 pressure in a bottle of champagne is around 6 atm. When the bottle is opened, the pressure in the vapor phase suddenly drops and an oversaturation of typically 5 is reached. After pouring the champagne into a glass the dissolved CO_2 molecules escape by forming bubbles only a small part escapes by diffusion to the surface. These particles are responsible for the repetitive production of bubbles rising in the form of bubble trains Fig. CO_2 bubbles nucleating from champagne at the bottom of a glass. Here, gas pockets entrapped inside cellulose particles serve as nucleation sites. The images, taken with a high speed video microscope, were kindly provided by G. The pressure on the concave side is higher. For drops it is increased compared to the vapor pressure of a planar surface under the same conditions. For bubbles it is reduced. Quantitatively this is described by the Kelvin equation. Capillary condensation plays an important role for the adsorption of liquids into porous materials and powders. It also causes the adhesion of particles. The condensing liquid forms a meniscus around the contact area of two particles which causes the meniscus force. We would like to study a clean solid surface. Lets assume we have produced a pure, clean surface in UHV ultrahigh vacuum. To which value do we have to reduce the pressure in the UHV chamber? Give only an estimation. You can assume that on a clean solid surface, most of the gas molecules which hit the surface are adsorbed. A hole of radius 0. Does all water run out? The plastic is nonwetting. Hexadecane wets the capillary. Calculate the surface tension of hexadecane using the simple Eq. Values for the correction factor are listed in the following table from Ref. Is it necessary to use the correction?

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Includes bibliographies. "Based on the Symposium on Interfaces sponsored by Industrial and engineering chemistry and the Division of Industrial and Engineering Chemistry of the American Chemical Society, Washington, D.C., June 15 and 16, " Reprinted from Industrial and engineering chemistry.

History[edit] The field of surface chemistry started with heterogeneous catalysis pioneered by Paul Sabatier on hydrogenation and Fritz Haber on the Haber process. The Langmuir adsorption equation is used to model monolayer adsorption where all surface adsorption sites have the same affinity for the adsorbing species. Gerhard Ertl in described for the first time the adsorption of hydrogen on a palladium surface using a novel technique called LEED. Surface chemistry[edit] Surface chemistry can be roughly defined as the study of chemical reactions at interfaces. It is closely related to surface engineering , which aims at modifying the chemical composition of a surface by incorporation of selected elements or functional groups that produce various desired effects or improvements in the properties of the surface or interface. Surface science is of particular importance to the fields of heterogeneous catalysis , electrochemistry , and geochemistry. Catalysis[edit] The adhesion of gas or liquid molecules to the surface is known as adsorption. However, it is difficult to study these phenomena in real catalyst particles, which have complex structures. Instead, well-defined single crystal surfaces of catalytically active materials such as platinum are often used as model catalysts. Multi-component materials systems are used to study interactions between catalytically active metal particles and supporting oxides; these are produced by growing ultra-thin films or particles on a single crystal surface. Results can be fed into chemical models or used toward the rational design of new catalysts. Reaction mechanisms can also be clarified due to the atomic-scale precision of surface science measurements. Adsorption and desorption events can be studied at atomically flat single crystal surfaces as a function of applied bias, time, and solution conditions using scanning probe microscopy [11] and surface X-ray scattering. Geochemistry[edit] Geologic phenomena such as iron cycling and soil contamination are controlled by the interfaces between minerals and their environment. The atomic-scale structure and chemical properties of mineral-solution interfaces are studied using in situ synchrotron X-ray techniques such as X-ray reflectivity , X-ray standing waves , and X-ray absorption spectroscopy as well as scanning probe microscopy. For example, studies of heavy metal or actinide adsorption onto mineral surfaces reveal molecular-scale details of adsorption, enabling more accurate predictions of how these contaminants travel through soils [13] or disrupt natural dissolution-precipitation cycles. It overlaps with surface chemistry. Some of the things investigated by surface physics include friction , surface states , surface diffusion , surface reconstruction , surface phonons and plasmons , epitaxy and surface enhanced Raman scattering , the emission and tunneling of electrons, spintronics , and the self-assembly of nanostructures on surfaces. In a confined liquid , defined by geometric constraints on a nanoscopic scale, most molecules sense some surface effects, which can result in physical properties grossly deviating from those of the bulk liquid. Analysis techniques[edit] The study and analysis of surfaces involves both physical and chemical analysis techniques. These include X-ray photoelectron spectroscopy , Auger electron spectroscopy , low-energy electron diffraction , electron energy loss spectroscopy , thermal desorption spectroscopy , ion scattering spectroscopy , secondary ion mass spectrometry , dual polarization interferometry , and other surface analysis methods included in the list of materials analysis methods. Many of these techniques require vacuum as they rely on the detection of electrons or ions emitted from the surface under study. This is found by an order of magnitude estimate for the number specific surface area of materials and the impingement rate formula from the kinetic theory of gases. Purely optical techniques can be used to study interfaces under a wide variety of conditions. Reflection-absorption infrared, dual polarisation interferometry, surface enhanced Raman and sum frequency generation spectroscopies can be used to probe solidâ€"vacuum as well as solidâ€"gas, solidâ€"liquid, and liquidâ€"gas surfaces. Multi-Parametric Surface Plasmon Resonance works in solid-gas, solid-liquid, liquid-gas surfaces and can detect even subnanometer layers. Dual Polarization Interferometry is used to quantify the order and disruption in birefringent thin films. X-ray scattering and spectroscopy techniques are also used to characterize surfaces and interfaces. While some of these measurements can be performed using laboratory X-ray sources , many require the high intensity and energy tunability of synchrotron radiation. Surface-extended X-ray absorption fine structure SEXAFS measurements reveal the coordination structure and chemical state of adsorbates. X-ray photoelectron spectroscopy XPS is a standard tool for measuring the chemical states of surface species and for detecting the presence of surface contamination. Surface sensitivity is achieved by detecting photoelectrons with kinetic energies of about eV , which have corresponding inelastic mean free paths of only a few nanometers. This technique has been extended to operate at near-ambient pressures ambient pressure XPS, AP-XPS to probe more realistic gas-solid and liquid-solid interfaces. These microscopies have considerably increased the ability and desire of surface scientists to measure the physical structure of many surfaces. For example, they make it possible to follow reactions at the solidâ€”gas interface in real space, if those proceed on a time scale accessible by the instrument.

7: Physics and Chemistry of Interfaces - Livro de fÃsico-quÃmica de superfÃcies.

The text reflects that physics and chemistry of surfaces is a diverse field of research which involves classical scientific and engineering disciplines. Fundamentals subject like thermodynamics of interfaces as well as applied topics such as wetting, friction, and lubrication are discussed.

8: Surface science - Wikipedia

Hans JÃ¼rgen Butt, Karlheinz Graf, and Michael Kappl Physics and Chemistry of Interfaces Second, Revised and Enlarged Edition WILEY-VCH WILEY-VCH Verlag GmbH & Co. KGaA.

9: Comparison of chemistry and physics - Wikipedia

It is unique in its attempt to treat the physics of surfaces, thin films and interfaces, surface chemistry, thermodynamics, statistical physics and the physics of the solid/electrolyte interface in an integral manner, rather than in separate compartments.

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