# A surface scientist's perspective on Biointer*phases*, or "Out of the Vacuum, into the Liquid"

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Surface Science evolved from the need to understand interfaces in semiconductor manufacturing and heterogeneous catalysis, and relied heavily on model surfaces mimicking specific aspects of the more complex "real" surfaces of technological relevance. Most methods to characterize the structure and composition of surfaces with atomic precision required a vacuum environment, if not for the probes used (electrons, ions, atoms, …), then to avoid contamination of the surfaces from an ambient atmosphere. Measured data from the first x-ray photoelectron spectroscopy experiments that probed the composition of implant surfaces and protein adsorption on these surfaces were too complex to be analyzed quantitatively with the concepts derived from inorganic model surfaces. I well remember the first presentations at the annual AVS symposia by Buddy Ratner in which he showed XPS data of explanted implant surfaces and other biomedical devices. Awe and disbelief was a common reaction in the audience. However, the message was clear that interfaces of biomedical relevance need to be better understood to improve the performance of biomedical devices.

Leaving the technologically well controllable vacuum environment for surface analysis and venturing into liquid—and finally biological— interfaces first seemed to be an oddity. The Surface Science community was curious, sympathetic, but not really interested. Fortunately, others were: the efforts to extend the surface science tool box to include *in situ* techniques coincided with rapid progress in many other research areas. Nanoscience provided the tools to make and control micro- and nanoscale structures, new concepts and strategies evolved from macromolecular and polymer chemistry, and advances in theory and simulations provided detailed descriptions of interface processes. Some of the new analysis techniques that were invented, rediscovered, or modified, enabled *in situ* or *post mortem* (removed after fatal failure) characterization of surfaces exposed to aqueous solutions or complex biological fluids with submonolayer (picomolar) sensitivity. It became possible to study the molecular conformation of polymers in liquids, to characterize micro- and nanopatterned surfaces used in cellular biology and biomedical applications, and to observe in real time how living organisms, bacteria or cells respond to external stimuli. Today, as much as in the past, new instruments allow new discoveries and lead to technological breakthroughs (just think about the invention of the microscope or telescope); and this was realized rapidly in the scientific community interested in the properties of complex interfaces.

The new collaborations and alliances formed over the last ten years in biomedical interface and biomimetic material science, environmental science and marine biofouling include a broad range of disciplines. Their common goal is a quantitative description of the structure, composition and function of the interphase, and a detailed understanding how cells or organisms respond to artificial surfaces, be it a ceramic or metallic implant, or a nanostructured surface exposing adhesion motifs for cell attachment. A further and equally important goal is that once it is understood how nature addresses and solves problems, we should be able to incorporate the natural design strategies into novel biomimetic materials and hybrid devices. Biological systems are hierarchical, both in their length scale and in time. Fast events on the molecular scale lead to growth and aging of macroscopic organisms. Life is not static; it is dynamic, driven by gradients and it stays far away from thermodynamic equilibrium (death). This dynamic state is also characteristic of biointerfaces: They change in time and respond to stress. Most of the techniques and methods available today provide us a snapshot of the biosystem at a particular time when it was fixed for analysis. *In vivo* characterization of biointerfaces, e.g., in implants, is a vision, but may be not too far away considering the rapid progress made in invasive and noninvasive sensors.

We are all aware that interface problems are abundant in all aspects of life, particularly in the warmer climate zones where these problems often are exacerbated. Biofouling occurs not only on biological devices, but also at water/ solid interfaces in the environment. In the fouling of water purification membranes, and in all technical problems and challenges associated with providing clean water for the growing populations, interfaces of one kind or another are involved.

So why did we start Biointer*phases*, which is placed amongst several competitors trying to publish the best science in the emerging field of "biological" surface science? If there would not be some very special and unique features to our new journal, we would not have taken over the responsibility to make this a successful and rewarding enterprise.

First, let us remark on the title, with includes the word "*phase*" in italics: Except for the solid/ vacuum interface at low temperatures, there probably is no other twodimensional interface. In particular in solutions there will always be a gradient between the solid substrate and the bulk solution, and the same is true for solid/solid and inorganic/organic, and organic/organic interfaces; they all have a higher dimension, and a gradient which drives interfacial processes. Hence, the use of "inter*phase*" rather than "interface" is to emphasise the higher dimensionality of the systems we discuss here.

The idea to launch a journal on biointerphase science has been around for a long time in the community. As is plainly evident, those active in the field spread their publications over several chemistry, physics and chemical, physical journals. There is no unique forum for the community to discuss issues of common interest, to announce meetings and other events, or to provide a job forum for post docs and young scientists. And finally, since biointerphase science involves scientists from all continents and many scientific fields, a common and freely accessible platform is needed to communicate our results and facilitate new collaborations.

These are good and honorable reasons to launch a new journal, but how will it be able to survive financially while providing unrestricted and free access to its content? First, we believe that those who are part of the community will support the journal by submitting their best work, and paying the very competitive and modest publication charges. Second, we will offer an interesting and diverse content including: regular articles; critical reviews; editorial commentary and perspectives, reports on ongoing research programs; opinionated essays and letters to the editor. This will hopefully not only make Biointer*phases* an attractive journal to read, but also has the potential to attract commercial and philanthropic sponsors. Third, we will strive for a very short turn around time (45 days) from submission to appearance on the web for articles requiring minimal editing or changes. But, of course, ultimately, the journals success will hinge on the acceptance and support by the biointer*phase* community.

Without the continuing support and financial engagement of the AVS this new journal would not have been what it is and what it will be. Without the willingness of all our colleagues and friends who serve on the Advisory Board and as co-editors, the Journal would not have started. We thank them all for their generous support providing ideas, concepts, and much of their precious time. Last, but by no means least, our thanks goes to Nancy Schultheis at the editorial office, whose untiring efforts drove the publication of this first issue of Biointer*phases*.

Enjoy reading our first issue, and look on our web page for the papers, reviews, and commentaries which will be posted as soon as they are ready to be printed.