SMALL IS DIFFERENT: EMERGENT PHYSICS AND CHEMISTRY AT SURFACES AND INTERFACES

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When the scale of materials structures is reduced to the nanoscale, emergent physical and chemical behavior often occurs, that is not commonly expected, or deduced, from knowledge learned at larger sizes. Such new behavior may be found when the size of the interrogated physical system becomes comparable to a phenomena-dependent characteristic length-scale; for example, the width of a quantum wire approaches the Fermi wave- length of the conducting electrons, or the dimensions of a liquid bridge, or a nanojet, approach the wave-length of a hydrodynamical instability underlying collapse or droplet ejection. Using computer-based simulations we highlight and discuss such emergent phenomena, focusing on interfacial nanostructures. Systems that we discuss include: electrons in 2D semiconductor quantum dots, nano-scale junctions, liquid bridges and jets, hole formation and self-repair mechanisms in lipid bilayer membranes, and interfacial control of the chemical catalytic properties of surface supported clusters.