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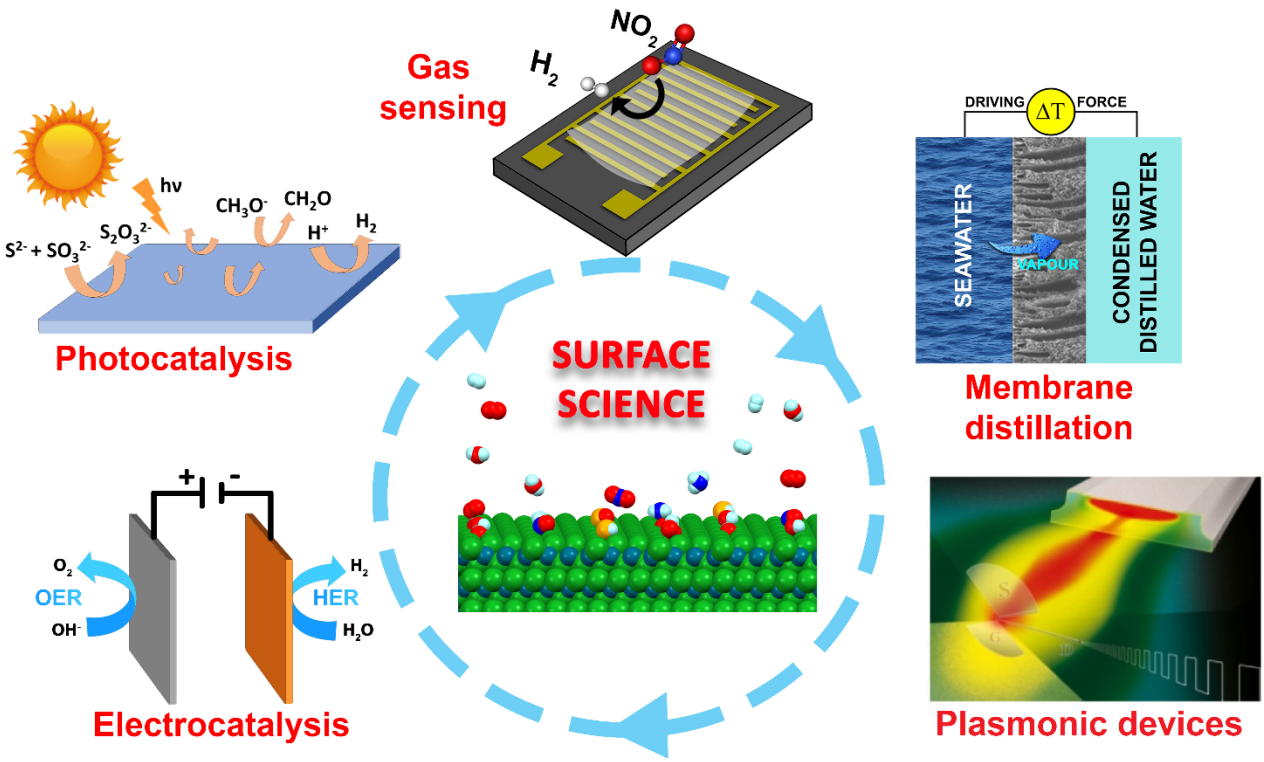
Surface science: opportunities and challenges for applications in catalysis, gas sensing, desalination and plasmonic devices



Abstract

Surface science has the goal to shed light on the fundamental aspects of chemistry and physics occurring at surfaces and interfaces. Especially, the study of chemical processes and electronic excitations at solid surfaces represents a powerful tool to unveil novel physicochemical concepts with direct implications for several fields, such as catalysis [1-3], gas sensing[4], desalination[5-7], and plasmonics [8, 9], and, moreover, to test the ambient stability of materials and devices [10-12]. Moreover, recent upgrades of experimental tools and computational capabilities have opened new opportunities and challenges for surface science.

In this talk, I will highlight recent advances in application fields strictly connected to novel concepts emerging in surface science. Specifically, I will show for selected case-study examples that surface oxidation can be unexpectedly beneficial for improving the efficiency in electrocatalysis (hydrogen evolution reaction and oxygen evolution reaction) [2, 13] and photocatalysis [1], as well as in gas

sensing [4, 14]. Moreover, I will discuss the adsorption-assisted mechanism in membrane distillation for seawater desalination [15]. In all these applications, surface-science methodologies (both experimental and theoretical) have unveiled new physicochemical processes, whose efficiency can be further tuned by controlling surface phenomena, thus paving the way for a new era for the investigation of surfaces and interfaces of advanced materials.

Furthermore, I will discuss about the role of surface collective excitations (surface plasmons)[9] in novel applications such as thermoplasmonic membrane distillation for seawater desalination [6, 7, 16] and recovery of minerals [5] and, moreover, plasma-wave THz photodetection [13, 17-19].

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