2nd World Congress and Expo on
Nanotechnology and Material Science
April 04-06, 2016 at Dubai, UAE

Cesium growth and characterization on the $SrTiO_3$(100) surface: Water adsorption

D. Vlachos, M. Kamaratos, E. Giotopoulou and S.D. Foulias
Department of Physics, University of Ioannina, Greece

In this work, we investigate the growth of Cs overlayer on the $SrTiO_3$(100) surface (STO) at room temperature by means of Auger electron spectroscopy, low energy electron diffraction, electron energy loss spectroscopy, thermal desorption spectroscopy and work function measurements [1]. According to the results, cesium grows in a single amorphous layer, showing different morphology from that on other insulating substrates. The Cs overlayer approximates a two-dimensional metallic phase. No indications for the reduction of the substrate and a Cs–O compound are found. Thermal annealing desorbs part of the metallic Cs, inducing at the same time the surface diffusion of the Cs adatoms to higher binding energy states. The growth and adsorption kinetics of Cs on the STO, shows substantial differences to that of other alkalis such as K [2] and Li [3]. The reasons for that are discussed.Having characterized the cesium overlayer on the STO(100) surface, our next step was to study the adsorption of water on that surface system. The interest on water-surface interaction originates not only from fundamental scientific reasons, namely to understand better wetting and corrosion phenomena, but also from environmental concerns underlining the increasing importance of hydrogen as a fuel for green energy production. Despite the scientific effort, our knowledge of water adsorption with additives on surfaces remains incomplete. Thus here, we investigate experimentally the role of cesium as a promoter for water adsorption on the STO surface. In general, strontium titanate is a perovskite with outstanding catalytic properties in photoelectrolysis of water [4]. The motivation of this work is the well known enhancement of the catalytic properties of metal oxides by the addition of alkali species. The results show that water neither dissociates nor interacts strongly with the predeposited cesium on the surface. In addition, no any Cs-H_2O compound, was detected, concluding that water adsorbs non-dissociatively on the cesiated STO surface. In contrast, much earlier experiments showed partial dissociation of water and oxidation of the clean STO substrate [5], while rapid dissociation of water has also been observed on cesium covered MgO(100) surface [6]. The situation was different when we tried simultaneous adsorption of Cs and H_2O on the STO(100) surface. Those experiments resulted in the detection of Cs_2O, only if the corresponding Cs coverage was equivalent or larger than 1 monolayer. In that sense, a prerequisite minimum amount of Cs is necessary in order to react with H_2O and form cesium oxide. Thus, we conclude that under certain experimental conditions, coadsorption of Cs with water can dissociate the molecule of H_2O, resulting in the oxidation of cesium.

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Biography:

Dimitrios Vlachos is a physicist working for more than 25 years in the field of surface science. His current interests are mainly focused on the development and characterization of metallic and oxide nanostructures on surfaces. He also interested on how this kind of surface systems interact with gases such as H_2, O_2, CO_2 and water. The investigation of these systems is carried out from the structural and electronic point of view, based on a wide variety of surface analytical techniques in my home laboratory in the University of Ioannina in Greece, and the use of synchrotron radiation facilities in laboratories in abroad such as Max-lab in Sweden and ELETTRA in Italy.