Preparation of atomically flat Au (111) surfaces for biological applications

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Self-Assembled Monolayers on solid surfaces has been widely investigated during the past decade due to interesting SAM's phenomena as adsorption, adhesion, wetting, lubrication or friction [1]. But the immobilization of biological molecules on surfaces provides a new way for studies on the behaviour of biological structures such as proteins and cells [2], but is it also the basis for sophisticated biomolecular architectures with great technological interest [3]. A critical aspect for well developing the SAM on any surface is to have a good defined substrate, of very low roughness, due to the great influence of the surface on the final structure of the monolayer. A surface that approaches an atomically flat structure gives more compactness to the monolayer.

In general, existing several methods to obtain Au (111) surfaces, they require, at least, complex and expensive instrumentation [4] – [6]. In this work we present a recently developed procedure to prepare atomically flat Au (111) surfaces with a mean roughness of 2-5 Å with terrace areas of at least 5 μm^2 in order to study thiol-self assembled monolayers and/or immobilized biological structures by Atomic Force Microscopy. The procedure describes an easy, successful and reasonably low priced method to obtain atomically flat gold surfaces, thus it does not require complex instrumentation. Easy to prepare, to store, and to chemically modify, particularly suitable in biological investigations.

Fig. 1 is an AFM image of the surface prepared following the described procedure. The surface consists in gold single-crystal islands, ranging between 0,5 μm and 2 μm in size, randomly distributed on the single-crystal silicon surface.

Several studies have been carried out to determine the influence of the crystallographic plane of the substrate in the final characteristics of the gold islands: shape, roughness, area and stability against several organic solvents. Also X-ray diffractometric patterns of these surfaces show that the only crystallographic plane is the (111), as it was expected, suggesting that the gold islands are indeed Au (111) single crystals.

Finally, three different entities have been chosen to evaluate the applicability of the surface purposed: thioalkanes, thiolated oligonucleotides and peptides. Fig. 2 shows an AFM image of a gold single crystal with glutaraldehyde bonded to a monolayer of cystamine, that it is only present on the gold surface. In this figure it is clearly visible that the organic molecule is deposited only in the single-crystal gold terraces thanks its thiol group, and not on the silicon substrate.

In conclusion, it is described a method to obtain atomically flat Au (111) surfaces really suitable for preparing SAM of alkanethiols and for immobilizing biological structures with thiol groups. Although all the advantages of this method, is its simplicity, successful and low priced what also must be highlighted.

Fig 1. AFM image in tapping mode of Au (111) monocrystals on silicon substrate. Atomically flat gold surfaces of more than 1 μm can be observed. Image size10 μm x 10 μm.

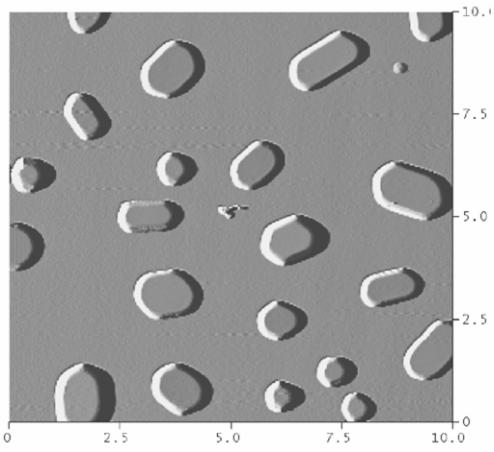
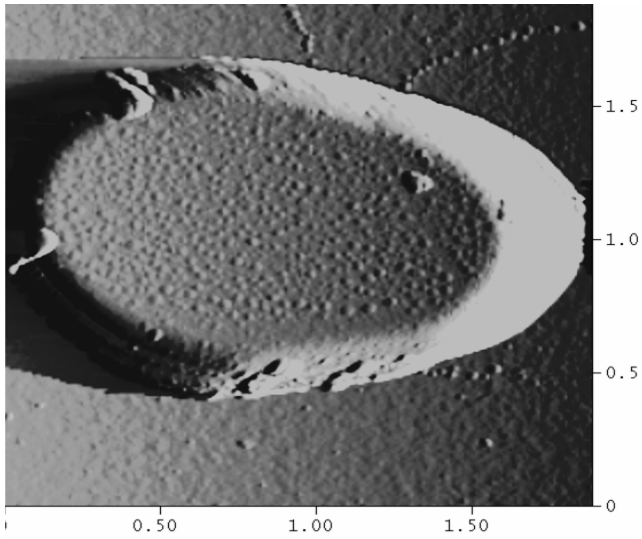


Fig 2: Gold monocrystal with glutaraldehyde-cystamine molecules. Image size 2 μm



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