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A chemical bonding study of the TiN:O/c-Si interface by X-Ray Photoelectron Spectroscopy (XPS)

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Titanium-based thin films are used for a great number of applications, such as hard coating in cutting tools, molds, catalyst diffusion barriers, and in microelectronic devices. Although the ubiquity of applications, the chemical and physical aspects of titanium-based thin film adhesion onto different substrates continue being a challenge and its atomic bonding properties are not fully understood. Furthermore, as the interface determines many characteristics of the film by prompting the bulk properties of the grown material, a detailed study of the first atomic layers is an interesting route to gain physical inside on the adhesion properties of the coating. Last but not least, the presence of residual oxygen in the industrial deposition chamber is sometime unavoidable and its influence on the films properties is important to be taking in account. Therefore, in order to investigate de chemical bonding at the TiN:O thin film/ polished crystalline Si (c-Si) substrate interface were studied. The thin films were deposited by IBD (Ion Beam Deposition) during 5s ($T=350^0C$) giving a ~3Å average thickness, as estimated by the material deposition rate. The electronic structure at the interface TiN:O/Si was scrutinized by XPS (X-ray photoelectron spectroscopy, 1485.6eV) in a UHV chamber attached to the IBD deposition system, i.e the studied samples are free from atmospheric contamination. The study indicates the presence of Ti-Si, Ti-O, Si-O, Ti-N and Si-N bonds at the that TiN:O/Si interface (assumed to be around ~5Å the probed region by XPS with X-ray energy used in the measurement). The percentage of the different bonds at the interface are quantified and reported. By introducing H_2 during the film growth, the incorporation of oxygen is controlled and structural characteristic of the interface modified. Finally, the nanostructuration of the Si substrate surface by noble gas ion bombardment and its influence on the bonding structures at the TiN:O/c-Si interface will be presented and discussed.

Keywords
Interface
TiN
XPS