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Influence of H2 on the TiN/Si interface microstructure elucidated by X-ray photoelectron spectroscopy (XPS)

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Titanium nitride (TiN) thin films are broadly used in the micro- and nanoelectronics industry. Most of TiN application requires avoiding impurities incorporation, particularly oxygen at the interface, to guarantee good film adhesion to the substrate and physical properties. In fact, minute quantities of impurities, particularly oxygen normally stemming from adventitious residual H_2O, seriously jeopardize the thin film proprieties.[i] In this paper, a comprehensive X-ray photoelectron spectroscopy (XPS) study of the local bonds occurring in the first atomic layers (~3-5 A) of TiN grown at T< 350 ^{0}C by ion beam assisted deposition on crystalline silicon is reported. The XPS analyses is performed in an UHV chamber attached. The main source of oxygen in the preparation chamber comes from H_2O (~10^{-7} mbar). The substrates are prepared by ion beam cleaning involving Xe^+ ion bombardment at different partial pressures of molecular H_2. The studied interfaces deposited on the cleaned c-Si substrates are studied at different hydrogen pressure conditions too. In fact, increasing the H_2 partial pressures during the interface growth promote the formation of Si-Ti bonds in detriment of Si-N and Si-O. The results show that the bombarding cleaning procedure and the interface growth depend on the occupation probability of H_2 and H_2O on the substrate. Clues about the ideal H_2/H_2O ratio preventing as much as possible the incorporation of oxygen are discussed and suggested. The use of these finding to be applied on TiN coating on metals are also presented.

[i] Veprek, S.; Karvankova, P.; Veprek-Heijman, M. G. J. Possible role of oxygen impurities in degradation of nc-TiN□a-Si3N4 nanocomposites. J. Vac. Sci. Technol. B Microelectron. Nanom. Struct. 2005, 23 no. 6, L17-L21.

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