Influence of plasma pulsing on active species kinetics in low pressure radiofrequency ICP plasmas

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There is an increasing interest in developing surface treatment processes close to room temperature, for instance for flexible electronics. Pulsed Plasma Enhanced Chemical Vapor deposition (PECVD) is one route to reduce the deposition temperature of thin films. Thin films generally deposited above 300°C were shown to be successfully deposited on thermally sensitive substrates such as polymeric films. The challenge is to control the density and kinetics of active species (ions and radicals) so that thin films with the properties of films usually deposited at high temperature may be obtained at much lower temperature.

Radiofrequency inductively coupled plasmas (ICP) operated in pulse mode (at a frequency in between 200 Hz and 5 kHz) were previously shown to deposit dense SiO_2 films at low temperature. It was furthermore recently shown to allow the deposition of nanocrystallized anatase TiO_2 photocatalytic films on polymeric substrates at T < 80°C, whereas anatase is usually obtained above 300°C.

The density and kinetics of charged species (electrons and positive ions) and oxygen atoms have been investigated by Langmuir probe and time resolved optical emission spectroscopy in pulsed low pressure rf ICP plasmas created in pure oxygen and oxygen/organometallic vapour mixtures. Hexamethyldisiloxane (HMDSO) and titanium isopropoxyde (TTIP) organometallic precursors, used for SiO_2 and TiO_2 deposition respectively, are investigated. The respective roles of electrons and oxygen atoms in the dissociation of the organosilicon precursor are discussed in detail.