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# Nitrogen Incorporation in $Al_2O_3$ Thin Films Prepared by Pulsed Ultrasonic Sprayed Pyrolysis

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The electrical characteristics and the chemical composition profiles determined by XPS and SIMS for aluminum oxide thin films deposited by pulsed ultrasonic spray pyrolysis are reported. The films were deposited on c-Si at 550 ºC using a chemical solution of aluminum acetylacetonate as source of aluminum and N,N-Dimethylformamide as solvent, in addition a $H_2O$-$NH_4OH$ mist was supplied simultaneously during deposition to improve the overall properties of these films. The results show that there is nitrogen incorporation in the films at the interface with the Si substrate. There is also a clear migration of silicon into the deposited film. The thickness of the films was in the range of 30 nm. Infrared spectroscopy also shows the presence of Si-O bonds. The dielectric constant for these films was higher than 8 and their interface trap density at midgap was in the $10^{10}$ $eV^{-1}cm^{-2}$ range.

## Introduction

Aluminum oxide ($Al_2O_3$) thin films have been studied in different areas of technological research. This is because $Al_2O_3$ films present excellent physical and chemical properties. For example, in the microelectronic industry $Al_2O_3$ is considered, among other metallic oxides, a good candidate to replace the silicon oxide ($SiO_2$) as complementary metal-oxide-semiconductor transistors (CMOS) gate dielectric, and for future generation memory devices (1,2). Although aluminum oxide has a relatively low dielectric constant value (about 10), it has an edge over other alternative oxides, because presents a good thermodynamic stability and a high crystallization temperature (3) as well as a good interface quality when deposited on silicon as alumina thin films.

$Al_2O_3$ films have been deposited by a wide variety of techniques such as atomic layer deposition (ALD), metal organic chemical vapor deposition (MOCVD), and others (3-6). Previous work has shown that the addition of $H_2O$ improved the electrical, structural and optical properties of these films (7). More recent reports have shown that the addition of a source of nitrogen during deposition of the films can improve their properties (2,8).

In this work we studied the characteristics of $Al_2O_3$ when deposited with an additional source of nitrogen, using the spray pyrolysis technique to get the films. The spray pyrolysis technique is considered an inexpensive process that has been used to obtain high quality thin films with properties similar or superior to the ones obtained with



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