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Ultra-smooth nano-scale $BaTiO_3$ thin films by aerosol deposition method for high-k metal-insulator-metal capacitor application

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With the rapid development of portable electronic devices such as smart phone that needs multi-functionality and miniaturization, the integration technology of components has been a key issue in the electronic industries. Also, the high frequency applications have been noticeably increasing due to the rising demand for the wireless communications. These desired factors have produced many investigations into the technology and integration of components, such as multi-chip modules, system-in-a-package, and system-on-package. In order to realize the integration technologies, embedded thin film technology for passive components such as R, L, and C, which occupy the area of circuit boards larger than 50%, is essentially required. As a representative material for the passive components, ceramics have superior dielectric and thermal properties but there have been limits on the applications for the thin film process due the high sintering temperature higher than 1000 ^oC so most embedded ceramic films have been investigated as polymer composites.

As a promising candidate for the embedded ceramic thin film technology, aerosol deposition method (ADM) that is capable of fabricating dense ceramic films at-room temperature has been widely investigated as micro MEMs employing PZT-based piezoelectric materials, Al_2O_3-based integrate substrates, $BaTiO_3$-based embedded metal-insulator-metal capacitors, and so on. Especially, the embedded technology of $BaTiO_3$ thin films could be an effective solution as embedded decoupling capacitors to suppress the electromagnetic troubles such as electromagnetic interference and simultaneous switching noise in the high frequency applications, as well as high-k dielectric layers in complementary metal-oxide-semiconductor technology. The dielectric properties of the $BaTiO_3$ films grown by ADM process have shown superior properties despite the room-temperature deposition and there have also been reports on enhancement of dielectric properties by the heat treatments. However, the most researches were about the dielectric properties below MHz region and there have not yet been reported the microwave dielectric properties. In this study, we report the microwave dielectric properties of the $BaTiO_3$ thin films grown by AD and the micro patterning of the $BaTiO_3$ thin films are carried out to fabricate micro capacitors by inductively coupled plasma etching process.

Keywords: $BaTiO_3$ thin film, aerosol deposition method, high-k metal-insulator-metal capacitor, inductively coupled plasma etching process.