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Study of sputter deposited silicon dioxide films for temperature compensation of frequency filters

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Temperature compensated surface acoustic wave (TC-SAW) frequency filters have opened a new field of applications in mobile communication. As standard SAW filters show a temperature-dependent frequency drift of -20 ppm/K up to -40 ppm/K, many high-frequency applications as well as communication in narrow RF bands would not be possible. The application of silicon dioxide (SiO_2) for temperature compensation allows the reduction of the filter frequency drift of a TC-SAW filter down to 0 ppm/K [1]. However, the filter performance strongly depends on the quality of the deposited SiO_2 as it contributes to the acoustic wave propagation.
In this study, high-quality SiO_2 thin films deposited by the magnetron sputtering system scia Magna are presented. The influence of the RF substrate bias on the SiO_2 properties is investigated. It is shown, that the RF bias significantly influences the SiO_2 properties such as refractive index, stress and film density.
The applicability of the deposited SiO_2 films for TC-SAW filters is proven by SEM cross-section on TC-SAW filter structures. As the acoustic wave propagation and, thus, the device performance is influenced by any scattering site, the SiO_2 film has to be dense without any seams or voids. It is shown, that the introduction of the RF bias changes the film growth on the IDT finger structure from a void-dominated film to a uniform, void- and seamless coating well suitable for TC-SAW. Finally, the SiO_2 was deposited on a TC-SAW filter, which shows the expected reduction of temperature-drift.
[1] Wang et al., “A Zero TCF Band 13 SAW Duplexer”, IEEE International Ultrasonics Symposium Proceedings (2015), DOI: 10.1109/ULTSYM.2015.0092

Keywords
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