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Growth, properties, and applications of $Al_{1-x}Sc_xN$ thin films

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The discovery of enhanced piezoelectricity in solid solutions of AlN and ScN [1] is certainly one of the most important events in piezoelectric MEMS. As compared to pure AlN, it brought a crucial factor 2 to 3 improvement in a number of figures of merit governing the performance of MEMS devices. The aim of this talk is to give an overview of the present knowledge about this material, its properties, and demonstrated device performance. Growth issues, phase stability of metastable AlScN, and the disturbing formation of abnormally oriented grains in otherwise perfect (0001)-textured columnar microstructures are addressed. Piezoelectric and dielectric properties obtained from experiments are compared with results from density functional theory.[2][3] Figure of merits for a number of applications are presented and compared with the ones of AlN and PZT thin films.[4] In ultrasonic devices for communication and sensors, AlScN will replace in many cases AlN. The higher coupling factors allow for the exploitation of new resonator types that previously did not reach a high enough coupling. This is the case for instance with Lamb wave resonators. The strong coupling will also help to push thin film SAW devices for wireless sensors combined with identification tags. Our latest results in these areas will be presented. Some specific issues on device fabrication will be dealt with as well: patterning of AlScN and the growth of misaligned grains, or abnormally oriented grains.[5]

[1] M. Akiyama, T. Kamohara, K. Kano, A. Teshigahara, Y. Takeuchi, N. Kawahara, *Adv.Mat.* **2009**, *21*, 593.

[2] S. Mertin, B. Heinz, O. Rattunde, G. Christman, M.-A. Dubois, S. Nicolay, P. Muralt, *Surf Coat Technol* **2018**, *343*, 2.

[3] F. Parsapour, V. Pashchenko, N. Kurz, C. S. Sandu, T. LaGrange, K. Yamashita, V. Lebedev, P. Muralt, *Adv.Electr.Mat.* **2019**, *in press*.

[4] R. Matloub, M. Hadad, A. Mazzalai, N. Chidambaram, G. Moulard, C. Sandu, T. Metzger, P. Muralt, *Appl.Phys.Lett.* **2013**, *102*, 152903.

[5] C. S. Sandu, F. Parsapour, S. Mertin, V. Pashchenko, R. Matloub, T. LaGrange, B. Heinz, P. Muralt, *Phys. Status Solidi A* **2019**, *216*, 1800569.