# Structural Properties and Defect-Selective Etching of Aluminum Nitride Substrates

Matthias Bickermann*, Boris Epelbaum, Sabine Schmidt, Paul Heimann, Shunro Nagata, Albrecht Winnacker; *Department of Materials Science 6, University of Erlangen, Martensstr. 7, 91058 Erlangen, Germany; *corresponding author:* matthias.bickermann@ww.uni-erlangen.de

Recently, deep-UV optoelectronics and high-power microwave devices based on Al-rich III-nitrides were successfully demonstrated, but key properties will be improved by reducing structural defects present in these epilayers. In this context, the use of single-crystalline AlN substrates is most promising. We investigated as-grown surfaces as well as polished cuts of up to Ø 20mm bulk AlN crystals grown by physical vapor transport (PVT) in our laboratory. Wet chemical etching in KOH-NaOH eutectic solutions in conjunction with by SEM and AFM analysis was found to be an adequate technology for dislocation evaluation on Al-polar c-plane AlN surfaces. Using proper etching procedure, the etch pit density (EPD) was found to yield a reliable value for the dislocation density, in the range of 1x10^3 to 5x10^5 cm^-2 in our AlN crystals. Hexagonal pits of different size can be attributed to screw and edge dislocations. We also found edge dislocation patterns forming around screw dislocation etch pits on repeated etching. The edge dislocation nature was verified by micro-indentation experiments. Areas with different optical properties are shown to significantly differ in etch pattern, etching rate, and X-ray rocking curve width. Finally, on the N-polar surface, which is etched much more rapidly compared to the Al-polar surface, oriented pyramids are observed which differ in their dimensions in more than one order of magnitude; they are clearly attributed to defects.