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Nitride semiconductors for high power and high frequency electronic devices

Bulk Aluminium Nitride Substrates Tailored for Electronic Applications

M. Bickermann, C. Hartmann, A. Dittmar, F. Langhans, S. Kollowa, T. Schulz, M. Naumann, A. Kwasniewski, K. Irmscher, J. Wollweber
Leibniz Institute for Crystal Growth (IKZ) Berlin, Germany

Single-crystalline aluminum nitride (AlN) is a promising substrate material not only for AlGaN epilayers with high Al content, e.g. for solid-state deep-UV optoelectronics, but also for high temperature and high power applications. This presentation gives an overview of the status of AlN substrate preparation and discusses perspectives and challenges for GaN/AlGaN-based high power electronics.

AlN bulk single crystals are grown by the physical vapor transport (PVT) method at temperatures well above 2000°C. Crystals of high structural perfection (dislocation densities < 10^4 cm^-2) can be grown using AlN single crystal wafers as seeds. However, proper control of the PVT growth process is made difficult due to gradual changes of the reactor materials caused by attack of gaseous Al and unintentional incorporation of impurities (O, C, Si) into the growing crystals during growth. The latter determine the electrical, thermal, and optical properties of bulk AlN substrates. In turn, these properties can be adjusted at least partially by providing proper growth conditions or by employing doping.

We will present and discuss preparation of bulk AlN substrates for power electronics which are electrically semi-insulating even at temperatures beyond 1000°C, ones that provide weak n-type conductivity (n = 1.2 10^15 cm^-3, μ = 36.5 cm^2/Vs) at room temperature by Si doping, and ones that exhibit transmission in the deep-UV wavelength range (for optical applications).