Comparative study of initial growth stage in PVT growth of AlN on SiC and on native AlN single-crystalline substrates.

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As a consequence of its closest chemical nature to GaN, AlN nitride can provide the most appropriate conditions for epitaxial growth of GaN and GaAlN, which is of particular interest for deep-UV photonics. Recently the availability of bulk AlN crystals grown from the vapor phase and suitable for wafering and seed preparation has been reported by few research groups, but a seeded growth process, which is a prerequisite to achieve significant crystal enlargement, was not demonstrated until now. In this report we will present a detailed comparative study of PVT seeding process for AlN grown on native AlN and on SiC substrates of different orientations.

Crystal growth experiments have been performed using close-space physical vapor transport (PVT) with source to seed separation of 2 mm. Dense polycrystalline AlN ceramics containing less than 100 ppm of residual oxygen were heated by tungsten strip heater and served as a source of AlN vapor. Seed crystals 10 mm in diameter were cut from bulk AlN boules prepared by unidirectional crystallization and containing single grains up to 3-5 mm in size (3-5 grains per wafer) and from single-crystalline 6H-SiC (wafer orientations (0001), (10-10) and (01-15) have been tested). Typically, a 0.5 mm thick layer was grown within 2 hours at 2150 C in the atmosphere of pure nitrogen.

The main issue in homoepitaxial growth of AlN on native seed substrates appears to be aluminum oxynitride (ALON) poisoning of seed surface leading to polycrystalline growth at 1850-1950 C, i.e. well below the growth temperature of 2150 C needed for PVT of bulk AlN. Contrary, heteroepitaxial growth of AlN on SiC is relatively easy to achieve because of natural formation of thin buffer layers of Al_2OC and $2AlN*Al_2OC$ both having appropriate 2H structure. The most critical issue of AlN growth on SiC is cracking of grown layer upon cooling, as a result of very different thermal expansion. Optimization of the seeded growth process by the proper choice of SiC seed orientation and by the use of ultra-pure starting material will be demonstrated.