SUBLIMATION GROWTH OF BULK CRYSTALS OF ALN-RICH $(ALN)_X(SIC)_{1-X}$ SOLID SOLUTIONS

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AlN and SiC have very similar lattice constants (AlN: a = 3.1114 Å, c = 4,9792 Å; 2H-SiC: a = 3,0763 Å, c = 5,048 Å) but very different band-gaps (AlN: 6.1 eV, direct; 2H-SiC: 3.3 eV, indirect). Thus, solid solutions of $(AlN)_x(SiC)_{1-x}$ [1] are considered as wide band-gap semiconductors with promising properties [2]. Applications of $(AlN)_x(SiC)_{1-x}$ epilayers have been proposed in the field of UV optoelectronics [3] and high frequency electronics [4]. The availability of $(AlN)_x(SiC)_{1-x}$ substrates could be beneficiary for devices based on AlN, AlGaN, and $(AlN)_x(SiC)_{1-x}$, but a technology for bulk crystal growth of $(AlN)_x(SiC)_{1-x}$ has yet to be developed [5]. Most challenging technological issues are (i) to establish materials compatibility in high-temperature growth with Al and Si species in the gas phase, and (ii) to effectively control segregation at the growth interface to grow crystals with defined and homogeneous composition. In this presentation, we describe an approach to grow such bulk crystals in the high AlN-content region and present first results on their properties.

$(AlN)_x(SiC)_{1-x}$ bulk crystals have been grown by physical vapour transport, the common method to grow AlN and SiC, at temperatures exceeding 1900°C in tantalum carbide crucibles. During growth, source material (consisting of pre-sintered AlN powder with single-crystalline SiC pieces embedded on top) is evaporated and condenses on the cooler end of the container, in which a seed crystal was mounted. SiC single crystals were used as seeds because of their chemical stability and seeding ability [5]. We succeeded to grow a 1 inch diameter, 3.5 mm high single crystalline boule of $(AlN)_{0.92}(SiC)_{0.08}$ within 24 h of growth time, see Fig. 1. The Si content was evaluated by EDX measurements to 8.5% at with axial and radial variations of less than 2% at. Oxygen was detected by mass spectrometry only at levels of approx. 100 ppm.

The $(AlN)_{0.92}(SiC)_{0.08}$ crystal has a greenish coloration caused by an optical absorption band at approx. 670 nm (1.85 eV) which was never observed in pure AlN samples, and strong absorption below 300 nm (4.1 eV) as shown in Fig. 2a. Measurements of cathodoluminescence and thermally stimulated luminescence also yield significant differences between pure AlN and $(AlN)_x(SiC)_{1-x}$ samples, cf. Fig. 2b. The electrical resistivity exceeds our measurement limit of 10^9 Ohm-cm. The described approach allows preparation of homogeneous crystals at least in the high-Al content region with $x > 0.85$.

ICNS-8 Topic: Emerging Materials (III-V-N, InN, etc.)

a) b)

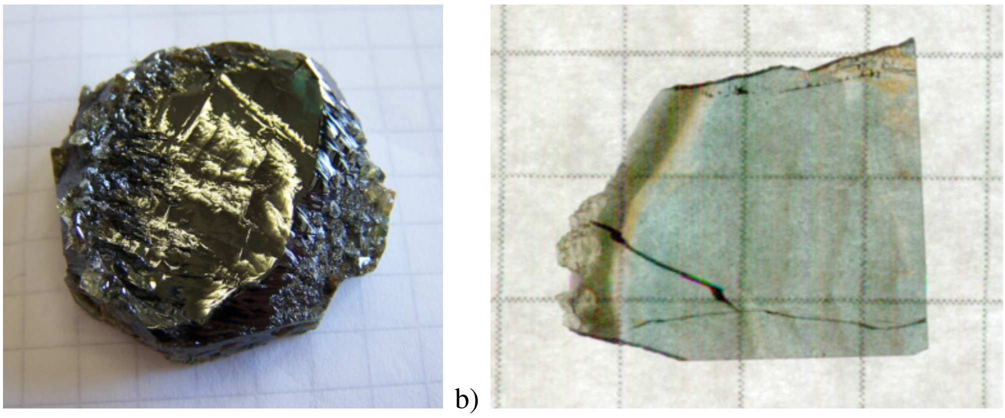

Fig. 1: a) Photograph (on 5 mm grid) of a $(AlN)_{0,92}(SiC)_{0,08}$ bulk crystal; b) photograph of a 410 µm mm thick wafer cut from this crystal (on 5 mm grid).

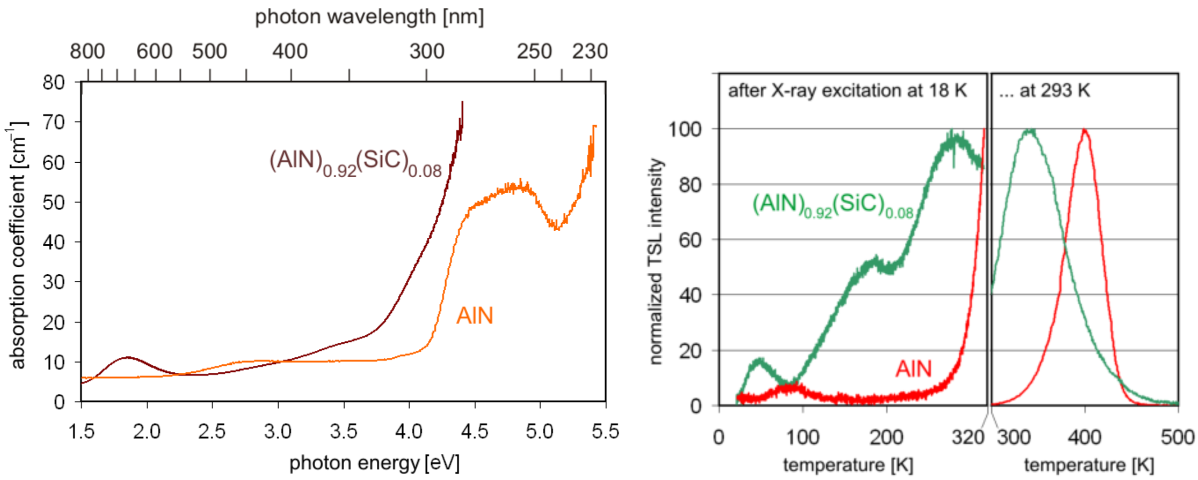

Fig. 2: Comparison of properties between AlN and $(AlN)_{0.92}(SiC)_{0.08}$ bulk crystals. a) Optical absorption in the visible and UV wavelength range. b) Thermally stimulated panchromatic luminescence after X-ray excitation at 18 K and 293 K.

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