MS13-2-7 X-ray analyses on the variation of the surface and structure properties of GaN and AlN single crystals subject to femtosecond laser irradiation
#MS13-2-7

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Abstract
GaN and AlN substrates are considered as hard-to-process materials due to their extreme hardness and strong stability against chemicals. Femtosecond laser sources can be used to treat GaN and AlN surfaces under ambient conditions, pressure and temperature supposedly without the destruction of their crystal structures and damaging the surface properties if laser parameters are adjusted. Specifically, the correct combination of exposure time and power are key for the conservation of the surface properties and structure and must be adjusted. In the present study GaN and AlN polished single crystals were exposed to femtosecond laser irradiation under ambient conditions. The irradiation treatment was carried out by a laser pulses having 350fs time duration on 1.03nm wavelength and a pulse power up to 2.1 mW. Repetition rate of the laser operation was 200kHz. The substrates before and after irradiation (Figure 1) were characterized by X-ray single crystal, X-ray micro-diffraction, 2D XRD and microscopy techniques in order to assess the presence of structural and surface effects: phase changes or conversion, oxidation, passivation etc. In parallel microthermal investigations (with the use of fast thermocouples) were carried out to assess the maximal temperature that can be attained under the irradiation. The single crystal micro-focus and powder microdiffraction studies were concentrated on different points (50 x 50 μm) of the GaN or AlN original and irradiated surfaces. With increasing irradiations exposure times and power, the surface of the GaN or AlN samples started to erode almost immediately. Nevertheless, the surface and bulk crystal structure was maintained up to certain time and power. In general, increasing the irradiations exposure times e.g. depth, led to the formation of pits and appearance of particles along the step edges, resulting in drastic roughening of the surface. Funding. This work was supported by the Bulgarian Science Research Found under grant DN-18/7 10.12.2017 (T.P. and B.Sh.)

Figure 1. Representation of GaN (a,b) and AlN c,d)