ESRF	**Experiment title: Influence of dopant atoms in cubic boron nitride (c-BN) thin films on lattice parameters and intrisic stress investigated by X-ray diffraction**	**Experiment number**: ME-130
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Report:

c-BN thin films can be deposited by quite a large number of different deposition methods. Using each of the methods results in highly stressed c-BN films. Modifications of deposition conditions which prevent high film stress do not yield the cubic BN phase either.

Owing to the large YOUNG´s modulus of c-BN, a stress of about 10 GPa corresponds to a strain of about one percent. On the other hand, incorporation of impurity atoms in c-BN may change the lattice constant by one or two percent even for low concentrations (few at.%). Hence, doping incorporation can influence the lattice constant to the same extent as the high stress does. Therefore, it should be possible to influence stress in c-BN by adding or leaving off appropriate dopant atoms during growth. The aim of this experiment was to investigate the influence of the incorporation of Al dopants on the lattice constant.

A preliminary study on such c-BN films revealed that the reflex of the (111) lattice planes is well pronounced, therefore, this reflex was chosen to be studied. To obtain a great variety of different orientations of these (111) planes relative to the sample surface, a monochromatic

beam of 1.1 Å was used. The angle between the incident beam and the sample surface was fixed at values of 0.25 °... 0.43 ° (slightly above the angle of external total reflection).

To access differently oriented planes, the detector was moved either around a horizontal axis (2θ) or a vertical axis (2ω) while the remaining axis was held constant.

The $\sin^2\Psi$ method (where Ψ is the angle between the vector normal to the lattice plane and the vector normal to the sample surface) was applied to analyze the biaxial stress state.

Assuming a reliable value for the c-BN POISSON´s ratio from the literature, the spacing $d_0(111)$ of the unstressed lattice planes was obtained. It was found that the unstressed lattice constant of c-BN grows linearly with the Al concentration, C_{Al}, and could be increased by up to at least 0,7 % (Fig. 1). For higher Al content, $d_0(111)$ went into saturation and for C_{Al} > 1.3 at.% no cubic BN phase formation could be observed.

The biaxial strain and, hence, stress values of the films were found independent of the aluminium percentage. When the bulk material value of YOUNG´s modulus was used for stress determination, all films were within -(15.6 ± 1.5) GPa.

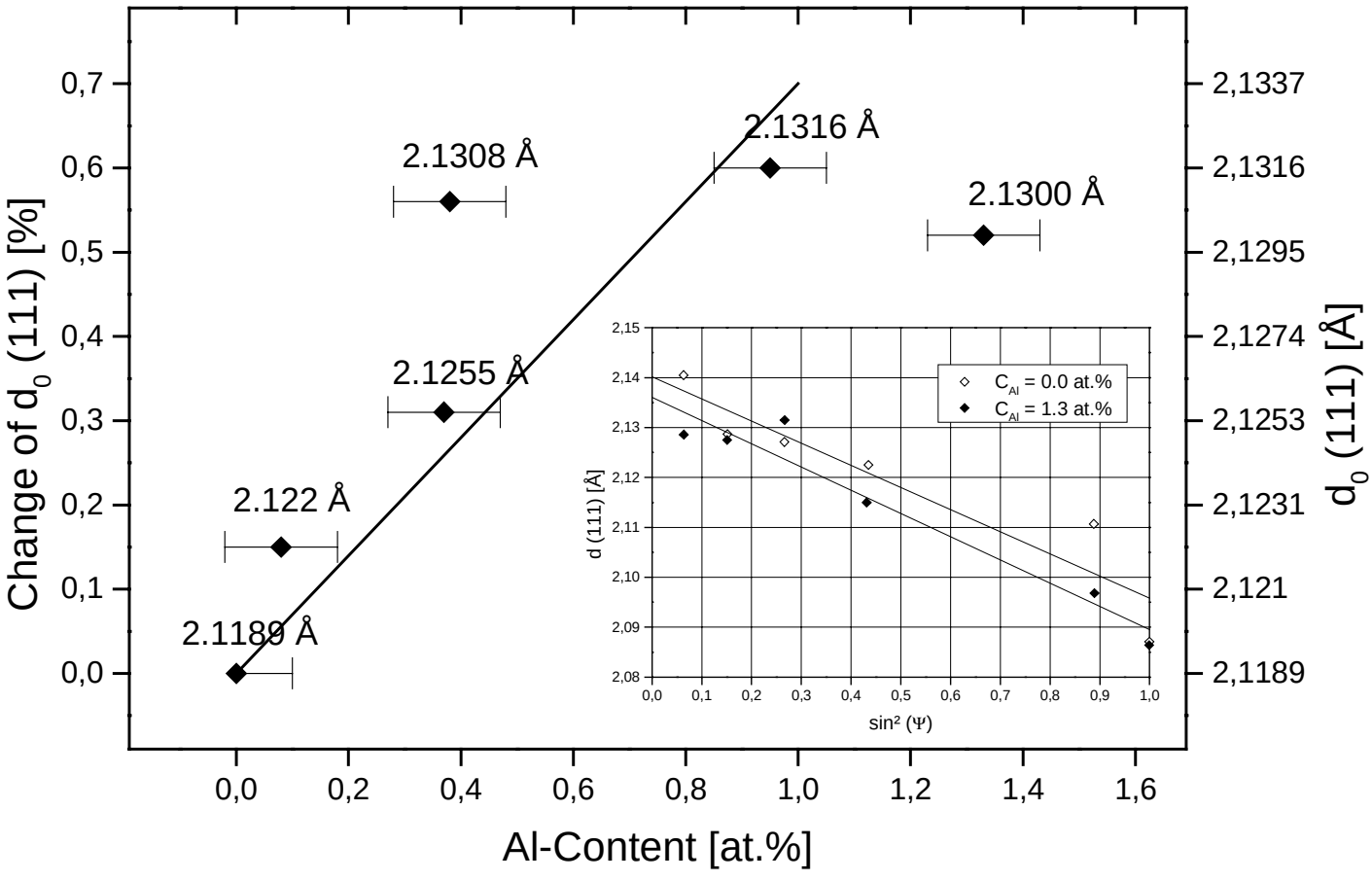

Figure 1 *Unstressed lattice constant d_0 of the c-BN (111) planes in dependence on the Al-content. The inset shows the plot of $d_{(111)}$ against $\sin^2\Psi$ for the sample with none and the highest Al content, respectively.*