Nitride semiconductors (nitrides of gallium, aluminium and indium) create large markets, for example, of white LEDs, of projectors based on LEDs or laser diodes, of high power and frequency transistors, and many others. However, in comparison with other semiconductors, the properties of nitrides are still not well explored.

Important GaN parameters, on which are still poorly known are diffusion coefficients describing how different atoms move in the crystal lattice in a function of temperature, conductivity, type, electric fields, strains. Also the role of various crystal defects should be elucidated.

The latter factor is very difficult to study because nitride semiconductors contain rather high defect concentrations of extended defects (dislocations) and point defects (interstitial atoms and vacancies). These defects influence strongly atomic diffusion, but they role is difficult to be quantitatively estimated.

This aim of this Proposal is determination of the activation energy and the mechanism of diffusion of magnesium, beryllium, oxygen and silicon (important dopants in nitride technology) along different crystallographic directions in GaN for various defect concentration and type of electrical conductivity.

Dopants will be introduced in the epitaxic processes (MBE- molecular beam epitaxy and MOVPE- metalorganic chemical vapour phase epitaxy), as well as by ion implantation. Diffusion of dopant atoms will be monitored after annealing at high temperatures.

The research proposed are world-unique because of the following reasons:

i) Project partner IWC PAN (Unipress) has an acces to GaN crystals of the record-low dislocation concentration and of various crystallographic orientations,
ii) Project partner IWC PAN has two kinds of epitaxy technology: MOVPE and MBE. In each of these technologies, point defects are different, so comparison of diffusion for both types of GaN layers will enable us to study how it depends on point defects,
iii) Project partner ITE has technology of implantation with very well controlled parameters,
iv) Project partner ITME (project coordinator) has two analytical methods, which are at much lower level in other academic laboratories. These are SIMS (secondary ion mass spectroscopy) with vertical resolution of about 0,1 nm and lateral resolution of about 10 □m, and DLTS (deep level transient spectroscopy).

Although the proposed research concerns the fundamental properties of matter it can in the future initiate important progress to the semiconductor technology. Diffusion of dopants (introduced during growth and ion implantation) takes place during growth of epitaxial layers, during technological operations. It is also crucial for the operation of devices since unintentional diffusion of dopants can reduce device life-time. It is expected that better understanding of the diffusion mechanisms should lead to new nitride-device technologies.