Gallium nitride, aluminium nitride and indium nitride are nitride semiconductors. They are the second group of materials (after silicon- germanium) used in electronics. The most popular nitride-based devices are white LEDs and blue lasers used in the Blu-ray devices. However, future belongs to laser projectors from the smallest in the cellular phones, to the biggest in cinema theatres or billboards. Such projectors will have perfect colour and spatial resolution, but also will be used in creation of 3-dimansional pictures without troublesome goggles.

The next nitride-based devices which will reach the mass markets are: i) transistors of high power and high frequency to be used in electric vehicles, in pholtovoltaics and radars, ii) far-ultraviolet (UVC) LEDs for disinfection and sterilization (extremely important in pandemic times), iii) emitters to data transmission (LiFi replacing WiFi in many situations).

Moreover, nitride lasers will find applications in many niche markets, for example, in quantum technologies for cooling the atoms down to almost zero K and for exciting them, what is the base of super-precise atomic clocks.

Despite of the commercial successes, nitride semiconductors are much more fifficult to be grown and processed comparing to other semiconductors: silicon, silicon carbide or gallium arsenide. Still a lot of basic parameters of nitrides are not known and many technologies are far from being mature.

This situation is related to a high density of defects which mask the real material parameters of nitrides. These defects are: dislocations caused by lattice mismatch of GaN to foreign substrates (sapphire or silicon), point defects caused by low growth-temperatures (at higher temperatures nitrides get decomposed).

In the Project proposed, we are going to study gallium vacancies (missing gallium atoms in the crystal lattice). They are the main source of migration of atoms of indium and aluminium. Such migration may have a positive effect, for example, at homogenization of the InGaN layers, but usually it is detrimental in the nitride device technology.

So far, our laboratory has been involved in the research on indium and aluminium diffusion in two-dimensional (flat) structures. In this Project, we are going to extend the research on three-dimensional (narrow stripes). Such structures will serve for construction of the three-dimensional projectors, however, before this technology is commercialized, we need information how gallium vacancies, atoms of indium and aluminium, move in such three-dimensional structure with the stripes walls exposed to the annealing atmosphere.