There is no doubt that GaN-on-GaN technology is required for a faster progress in nitride-based electronic and optoelectronic devices as vertical high power transistors, high electron mobility transistors or laser diodes. High structural quality gallium nitride (GaN) crystals, highly conductive and semi-insulating, are needed for preparing substrates for building mentioned devices.

One of the most promising results of bulk GaN crystallization have been presented for basic ammonothermal process. The idea of this process is as follows: GaN, used as feedstock, is dissolved in supercritical ammonia in one zone of a high-pressure autoclave. The dissolved feedstock is transported to the second zone, where solution is supersaturated and crystallization of GaN on native seeds takes place. An appropriate temperature gradient between dissolution and crystallization zones enables the convection mass transport. Some mineralizers are added to ammonia in order to accelerate its dissociation and enhance the solubility of GaN. Thus, the ammonothermal growth can be proceeded under different environment: basic or acidic. The type of environment is, obviously, determined by the choice of mineralizers. Ammonobasic growth makes use of alkali metals or their amides as mineralizers, while in ammonoacidic growth halide compounds are present.

Basic mineralizers include mainly lithium, sodium, or potassium amide. The most frequently studied basic mineralizer is potassium amide (KNH_2). However, a few data on the solubility experiments with the basic mineralizer sodium amide ($NaNH_2$) can be found in the literature. The reason for this is the generally accepted opinion of the higher solubility of KNH_2 in ammonia compared to $NaNH_2$.

It is stated and commonly believed that in the case of $NaNH_2$ used as a mineralizer, a normal course of solubility is observed (it increases with increasing the temperature), the solubility of GaN does not dependent on the concentration of the mineralizer, $NaNH_2$ dissolves very poorly in supercritical ammonia and $NaNH_2$ does not contribute to the dissolution of GaN. On the other hand, the best, in terms of structural quality, and the largest, in terms of thickness and lateral size, crystals are grown by basic ammonothermal method with $NaNH_2$ as the mineralizer and with a reverse course of solubility (it decreases with increasing the temperature; this is called a retrograde solubility mode). No doubt, this discrepancy should be explained.

The main goal of this project is a comprehensive study of the GaN solubility in the ammonothermal alkaline solution with $NaNH_2$ as the mineralizer. The GaN solubility as a function of temperature, pressure, dissolution time, mineralizer concentration and surface area of GaN feedstock will be investigated. The solubility of GaN in ammonobasic $NaNH_2$–GaN–NH_3 systems in the temperature range of 300–550 °C will be examined. First of all, the kinetics of the dissolution process will be investigated and time to reach a saturated solution will be determined. Then, the solubility of GaN as a function of temperature will be analyzed. The influence of ammonia pressure on the GaN solubility will also be studied. Finally, the influence of the mineralizer concentration on the dissolution process for selected values of temperature and pressure will be analyzed and determined.

This project will allow to expand the basic knowledge of the $NaNH_2$-GaN-NH_3 system. It will lead to a deeper understanding of the basic ammonothermal crystal growth process and a further, faster and better development of this technology.