Hexagonal boron nitride (h-BN) is a crystal that has attracted large interest among scientists in recent years. This material belongs to the family of 2D layered materials, which means that atoms in this crystal possess strong covalent bonds in plane but those planes are bound together only by weak van der Waals bonds. An important property of this material is his wide band gap with an energy around 6 eV. The size of the band gap makes this material an excellent insulator and also a prospective candidate as light emitter in the deep ultraviolet region (DUV). This kind of light may be used to purify water from microorganisms that are dangerous for human health and sterilize places where cleanliness is crucial e.g. operating theater. Dwindling resources of freshwater and an increasing world population render efficient ways of water purification especially important for the development of the human species.

To be able to create a light emitting diode (LED) that will emit light in the DUV region it is necessary to obtain an electrically conductive crystal. In most cases this is achieved by adding a small amount of atoms of different type to the crystal. Those additional atoms are called dopants. Suitably selected dopant atoms may increase the amount of free electrons in the conduction band of the crystal (this kind of crystal is called n type crystal) or holes, that correspond to the lack of an electron in the valence band (this kind of material is called p type crystal). To be able to create an LED we need both n- and p-type crystals. In some cases crystal defects may also work as dopants. The next very important technological step is to obtain high quality electrical contacts. Usually such contacts are formed using a lithographic pattern on the surface of the crystal. The pattern is made of a light sensitive polymer (resist) which allow us to create the desired shape on the material. Then, the exposed parts of the resist are rinsed with a developer which will expose the crystal surface in the regions where a metal layer should be deposited. A metal layer is then sputtered deposited on the so-prepared sample. The resist is washed away along with the metal sputtered on its surface. This way the metal remains only on the regions of the crystal, where resist was developed. Structures obtained this way have to be additional annealed at high temperatures and in suitable gas atmospheres in order to improve its technological parameters.

In this project we will develop electrical contacts for h-BN. We will use variety of metals that are used to obtain contacts on crystals similar to h-BN. A completely new element proposed in the research is to use a carbon contact layer between the metal and h-BN, which may result in the creation of BCN mixed material with a smaller band gap. The usage of carbon may result in a significant lowering of the contacts resistance. In the next step we will use the obtained knowledge about contacts to develop comb-like photoresistor structures based on boron nitride structures grown by our group by metalorganic vapour-phase epitaxy (MOVPE). Preliminary current-voltage characteristics show that annealing samples at high temperatures and in suitable gas atmospheres significantly decrease the resistance of the samples. Initial photoconductivity measurements performed on the comb-like structures, in which distance between adjacent electrodes was 10 μm and the length of the electrode was 500 μm, reveal a strong signal in the visible light range and in the near UV, as well as structures in the DUV range, that may be connected to interband transitions. Dedicated research on the detector structures will not only provide additional information about the usefulness of our electrical contacts for h-BN, but will allow us to obtain a deeper understanding about defects and dopants that are crucial for the development of efficient epitaxial boron nitride based LED structures emitting in the DUV region.