Deutsche Forschungsgemeinschaft (DFG) / Russian Foundation for Basic Research (RFBR):


Annotation:

Efficient and scalable single-photon sources (SPSs) are crucial to the development of numerous quantum information technologies, such as optical quantum computers and unconditionally secure communication lines. SPSs based on quantum dots have shown much progress in the last two decades, but under ambient conditions they are being overcome by the recent advances in color centers in diamond and related wide-bandgap semiconductors. Color centers are point defects in the crystal lattice that behave nearly as isolated atoms. This property allows to obtain bright photo- and electroluminescence with a sharp emission spectrum, which cannot be achieved with any other quantum optoelectronic system under ambient conditions. However, it is still challenging to design scalable and reproducible technologies based on these emitters. In particular, it is difficult to precisely combine them with photonic and electronic nanostructures that are needed for achieving high brightness and control.

This project aims at developing and investigating a novel class of bright SPSs on diamond, which operate under ambient conditions and that can be efficiently electrically driven. The project will generate an interdisciplinary collaboration and it is based on two recently proposed concepts. First, to enhance the emission properties of the color center we will use a planar antenna, which enables large extraction efficiencies and strong directional emission from materials with a large refractive index. This approach does not require fine spectral tuning nor precise positioning of the emitter at the nanoscale, which is beneficial for fabrication and device operation. Second, we will employ a novel electrical pumping scheme based on a Schottky diode, which gives the possibility of efficiently injecting minority carriers in diamond directly from the metal and it does not require complex and expensive p-i-n and p-n diamond junctions. We will create high-quality silicon-vacancy (SiV) centers in less than 100-nm-thick diamond membranes and build a planar antenna with electrodes on it. We will investigate the photon emission properties (focusing on brightness, directionality) under optical pumping and explore the possibility of electrical excitation of SiV centers at room an higher temperatures. Thus, we will demonstrate a proof of concepts of a highly efficient and chip-scale SPS that will serve as, and inspire, novel photonic sources for quantum information and quantum communication. Our activities will also generate valuable knowledge in nanophotonics and materials science, which shall be transferred to other application areas.

Cooperation partner:

M. Agio, University of Siegen

Publications:


**Conferences:**


