Resonant excitation of phonons in semiconductor nanostructures exploiting open optical cavity (REPOC)
dr Michał Kobecki
Horyzont Europa
(2024-09-01- 2026-08-31)

Finansowane przez Unię Europejską

Phonons are vibrations of atoms in solids that play a significant role in material science and solid-state physics. High-frequency phonons have gained attention in the fields of quantum technology and nanophononics. Their small wavelengths make tchem compatible with quantum nano-devices and their frequencies can surpass modern computation speeds. This potential makes phonons useful for qubits, quantum memories, hybrid systems, and elements in quantum computing networks. Exploring phonons and their interactions with other excitations is important for advancements in solid-state physics and quantum technology.

The project focuses on using a novel experimental method based on the optical open cavity to excite and detect coherent phonons in materials from the II-VI group of semiconductors. We plan to grow samples with an acoustic cavity enclosed in Distributed Bragg Reflectors, which support the cavity acoustic mode. By placing the sample inside the open optical cavity and adjusting its length, we can sweep the energy of the excitation photon, allowing comprehensive studies on the influence of photon energy on phonon generation efficiency. Additionally, we can achieve quasi-resonant excitation of phonons in the time domain by adjusting the length of the cavity in a way that the round-trip time of the laser pulse matches the frequency of the generated phonons, resonantly pumping the desired phonon frequency supported by the acoustic cavity. This experimental scheme will allow us to enhance the efficiency of phonon excitation by exploiting four resonances for coherent phonon generation: acoustic cavity resonance, optical cavity resonance, excitonic resonance, and in-phase (temporal) resonance excitation.

As a result of the project we expect to provide a comprehensive study on the efficiency of the high-frequency coherent phonon generation in the II-VI semiconductor nanostructures obtained by innovative experimental technique exploiting optical open cavity.