GRAPHAR: Graphene enabled optical phased array for LIDAR applications

Main area: LIDAR based on GRMs for autonomous vehicles
Keywords: graphene, lidar, optical phased array, integrated photonics
Duration: 36 months
Total project funding: € 483.300

Abstract

Light Detection and Ranging (LIDAR) is a ranging technique based on the measurement of the time of flight of a light pulse transmitted by the device and then reflected by a target. This operation is repeated multiple times in different directions to create a complete 3D mapping of the surrounding space with information about spatial placement and depth of objects. This technique is commonly used in many application fields enabling high resolution monitoring, surveying and mapping. Recently LIDAR attracted interest in in the field of autonomous control of vehicles, drones and robots, applications where LIDAR finds a potential market with high volume production. However, common LIDAR systems are based on bulky and expensive components that prevent the use in a broader range of applications. Most LIDAR systems include discrete free-space optical components and mechanical equipment for beam shaping and steering that cause increased cost, bulky size and high complexity. Integrated photonics is considered as the most promising technology to realize compact solid-state LIDAR systems with a large-scale, low-cost manufacturing. In this project we target a solid-state LIDAR system based on Optical Phased Array (OPA) because of its superior robustness and compactness. The key component is the LIDAR transmitter scanning head, where the OPA photonic integrated circuit is used for beam shaping and steering, thus avoiding the bulky moving parts. Silicon based OPA's with acceptable beam size and steering range have been demonstrated. However, silicon photonic technology imposes severe limitations to the maximum output power of the transmitter because of the material loss (free carrier absorption) and nonlinearities (inducing phase changes and extra losses).

GRAPHAR project has the ambition to demonstrate a compact, ruggedized, low cost and highly efficient OPA based on a low loss Silicon Nitride (SiN) photonic integrated circuit with integrated graphene thermal phase shifters. SiN is a CMOS compatible insulator with a large optical bandgap and a low third-order non-linearity allowing high power operations over a broadband range of wavelength, from visible to infrared. However, SiN exhibits lower refractive index compared to Si that means a weaker mode confinement in the waveguide and a thermo-optical coefficient about ten times lower than silicon. This makes common thermal phase shifters based on metallic micro-heaters much less efficient on SiN. Graphene represents the most promising solution to enable efficient phase shifting on SiN platforms. Graphene is more transparent than a metal and therefore can be placed closer to the SiN waveguide by at least a factor of five. Graphene exhibits excellent intrinsic thermal conductivity and high optical damage threshold. The combination of SiN waveguides for the OPA and graphene for the heaters represents an innovative solution to implement a high-power optical output LIDAR system. The immediate and unique advantage is the extended distance reach of the scanning system.

GRAPHAR project aims at demonstrating that graphene can enable a promising platform for solid-state LIDAR systems based on OPA with high output power. GRAPHAR project will gather the know-how and expertise on graphene-based optoelectronics gained within the framework of the Graphene Flagship in the WP8 (Optoelectronics) and WP10 (Wafer scale integration) and contribute to the expected impacts set out in the work programme of the Graphene Flagship.

Consortium

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