CO2-DETECT: Waveguide-Integrated Mid-Infrared Graphene Detectors for Optical Gas Sensor Systems

Main area: ARI08_Highly selective gas sensors based on GRMs
Keywords: waveguide-based gas sensors, optical gas sensors, nondispersive infrared gas sensors, CO2 sensor, waveguide-integrated graphene photo detector
Duration (months): 36
Total project funding: € 400.000

Abstract

Gas sensing technologies for carbon dioxide (CO2), carbon monoxide (CO), ethanol and hydrocarbons are important for a large variety of applications such as air quality monitoring and realizing ventilation-on-demand strategies in air-conditioning systems, medical applications, industrial safety systems, aeronautic and automotive applications, breath-based alcohol sensing, and environmental monitoring, including sensors for integration in mobile phones. However, for many of these applications existing gas sensors are too low-performance, bulky or too expensive. Thus, there is a critical need for gas sensor systems that are compact, highly sensitive and specific to the targeted gas, and low-cost.To address this need, we will develop highly integrated waveguide-based optical gas sensor systems based on mid-infrared (mid-IR) graphene detectors. Existing mid-IR photodetectors typically are based on compound semiconductors, which are not capable of being integrated on wafer-scale with silicon photonics, thus precluding the development of low cost optical gas sensors. The purpose of this project is to fill the current technology gap and demonstrate that a nondispersive infrared (NDIR) gas sensor system can be realized, based on mid-IR graphene detectors that are integrated with silicon photonic waveguide circuits. The proposed NDIR gas sensor consists of a broadband IR emitter that couples light to a mid-IR spiral waveguide, which is exposed to the target gas. Thereby, certain wavelength bands of the light are absorbed by the presence of gas molecules while the light travels through the waveguide, and these bands are then split into different waveguides by on-chip filters. The intensity of the signal at the end of the waveguide is detected by a graphene-based mid-IR detector and correlates with the concentration of the targeted gas (CO2) with high sensitivity and specificity.Securing the realization of waveguide-based NDIR gas sensor systems is vital for sustaining the competitiveness of SenseAir, the current world market leader for optical CO2 gas sensors, and to pave its way into the emerging multi-gas sensor market. With the emerging automotive air-conditioning market in sight, and the billion-unit-per-year smartphone market in mind, international competitors are already on their way to the same goal. To meet this challenge, we have assembled a world-class team, combining the gas-sensor experts of SenseAir with academic experts on silicon photonic devices, graphene 3D integration, graphene production and graphene modelling. With early entry into the graphene-based IR detector market, Europe can secure key intellectual property vital to future graphene-based ventures. The project perfectly aligns with the strategic roadmap of the Graphene Flagship consortium, in which gas sensors are identified as an important objective for pushing European industrial competitiveness.

Consortium

Frank Niklaus – KTH Royal Institure of Technology – Sweden – Funded by: VR/VINNOVA (Coordinator)

Hans Martin – SenseAir AB – Sweden – Funded by: Partner not requesting funding

Max Lemme – AMO GmbH – Germany – Funded by: Partner not requesting funding

Aron Cummings – Catalan Institute of Nanoscience and Nanotechnology – Spain – Funded by: MINECO-AEI