Plenary Speech: On-Chip Mid-Infrared Photonics
Speaker: Prof. Boris Mizaikoff, University Ulm, Germany
Time: 11:10-11:50, Friday Morning, May 24
Location: 9th Floor, Room 928, Beijing Debao Hotel

Abstract:

State-of-the-art sensing platforms ideally benefit from miniaturized and integrated optical technologies providing direct access to molecule-specific information. With point-of-care and personalized medicine becoming more prevalent, detection schemes eliminating reagents or labeled constituents facilitate localized on-site analysis close to real-time.

However, decreasing the analytically probed volume may adversely affect the associated analytical figures of merit such as the signal-to-noise-ratio, the representativeness of the sample, or the fidelity of the obtained analytical signal. Consequently, the guiding paradigm for the miniaturization of optical diagnostic devices should be creating chem/bio sensing platforms that are as small as still useful, rather than as small as possible, and that smartly capitalize on integrated photonics.

Mid-infrared (MIR; 3-20 μm) sensor technology is increasingly adopted in bioanalytics due to the inherent molecular specificity enabling the discrimination of molecular constituents at ppm-ppb concentration levels in condensed and vapor phase media. Recently emerging strategies taking advantage of innovative substrate-integrated waveguide technologies such as hollow waveguides and planar semiconductor waveguides (e.g., MIR Mach-Zehnder interferometers) in combination with highly efficient broadly tunable quantum cascade lasers facilitate miniaturized yet robust MIR diagnostic platforms for label-free chem/bio sensing and diagnostics [1-7].

[1] C. Charlton, et al., Applied Physics Letters, 86, 194102/1-3 (2005).
[2] C. Charlton, et al., Analytical Chemistry, 78, 4224-4227 (2006).
[3] C. Young, et al., Sensors and Actuators B, 140, 24-28 (2009).
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[7] M. Sieger, et al., Analytical Chemistry, 85, 3050-3052 (2013).

Invited Speech: Design Challenges in Silicon Photonics
Speaker: Prof. Wim Bogaerts, Ghent University, Belgium
Time: 08:30-09:10, Saturday Morning, May 25
Location: 9th Floor, Room 928, Beijing Debao Hotel

Abstract:

Silicon Photonics is rapidly growing into an industrially viable technology. Based on CMOS manufacturing technology, silicon photonics can be applied for complex, large-volume photonic applications. Also, the high refractive index contrast between silicon and its oxide makes it possible to use sub-micron waveguides. The combination of the high-quality manufacturing tools and the submicron waveguides enables large-scale photonic integration: building more complex optical circuits than possible with any other technology. This introduces several issues on the design level. While the technology is rapidly maturing, the design tools are still falling short. The combination of high index contrast and large-scale, complex circuits introduces design challenges that were hitherto not encountered in integrated photonics.

First of all, the high index contrast puts significant demands on physical simulation: full-vectorial electromagnetic modelling is quite essential for accurate device modelling. Also, silicon photonics is essential a multi-physics system, which combines optical, electrical and thermal effects. But this cannot easily be extended to a full circuit. Scaling towards behavioural models that capture the richness of photonics, including the details of different physics, is not trivial. To capture that richness, all the relevant signal information should also be processed at signal level. In photonics, this is much more than voltage and current: optical power and phase should be incorporated for all the wavelengths in use.

The high index contrast introduces additional problems. One that is variability: nanometer-scale geometric variations already have a measurable impact on device performance. Taking this into account at the circuit level is not straightforward. Traditional corner analysis, as used in electronics design, is not sufficient, as photonics functionality is affected by many more aspect than just 'fast' and 'slow'. This multidimensional variability should be propagated from the process level all the way up to circuit yield prediction.

Additional challenges exist at layout level, where routing of photonic waveguides in a single layer can be difficult. Not only does one need to respect bend radius and spacing, but also topological constraints can be problematic: photonics cannot easily accommodate multiple routing layers, but on the other hand it can tolerate a reasonable number of waveguide crossings. At the design verification stage, similar differences between photonics and electronics introduce difficulties. For instance, how to recognize photonic connectivity when evanescent coupling is possible?

We will discuss these challenges in more details, and already propose some initial solutions to address these.

Invited Speech: Manipulating Light with Surface Plasmon Nanostructures
Speaker: Prof. Junpeng Guo, University of Alabama in Huntsville, USA
Time: 09:10-09:50, Saturday Morning, May 25
Location: 9th Floor, Room 928, Beijing Debao Hotel

Abstract:

Surface plasmons are free electron oscillations on metal surfaces. Surface plasmons also can occur in metal nanostructures. Surface plasmons in metal nanostructures have intrinsic oscillation frequencies, which are determined by the size and geometry of the structures as well as the optical constants of the materials. The intrinsic oscillation of surface plasmons is called localized surface plasmon resonance (LSPR). Localized surface plasmon resonances are coupled with optical resonances that confine photons near metal nanostructure surfaces. Localized surface plasmon resonances in random and periodic metal nanostructures such as nanohole and nanoparticle arrays have been extensively investigated. In this talk, I will review several new surface plasmon resonance nanostructures for controlling light. One structure is the super-period metal nano-grating structure that enables a new kind of surface plasmon resonance spectrometers. Another is the gap plasmon resonance nanostructure that can completely trap light.

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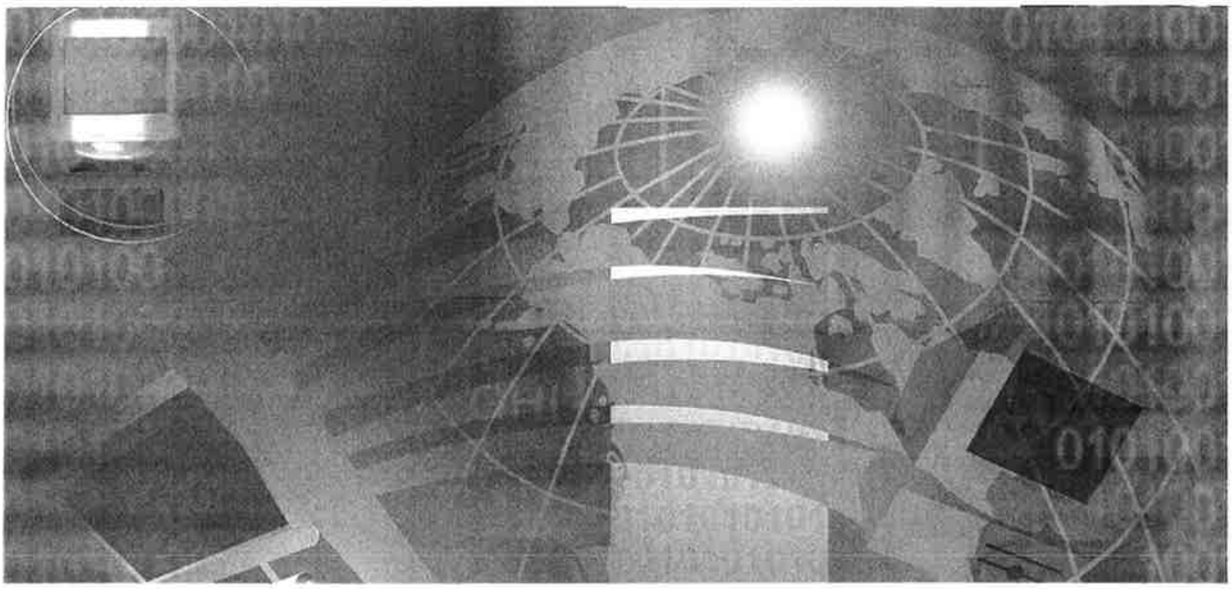

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