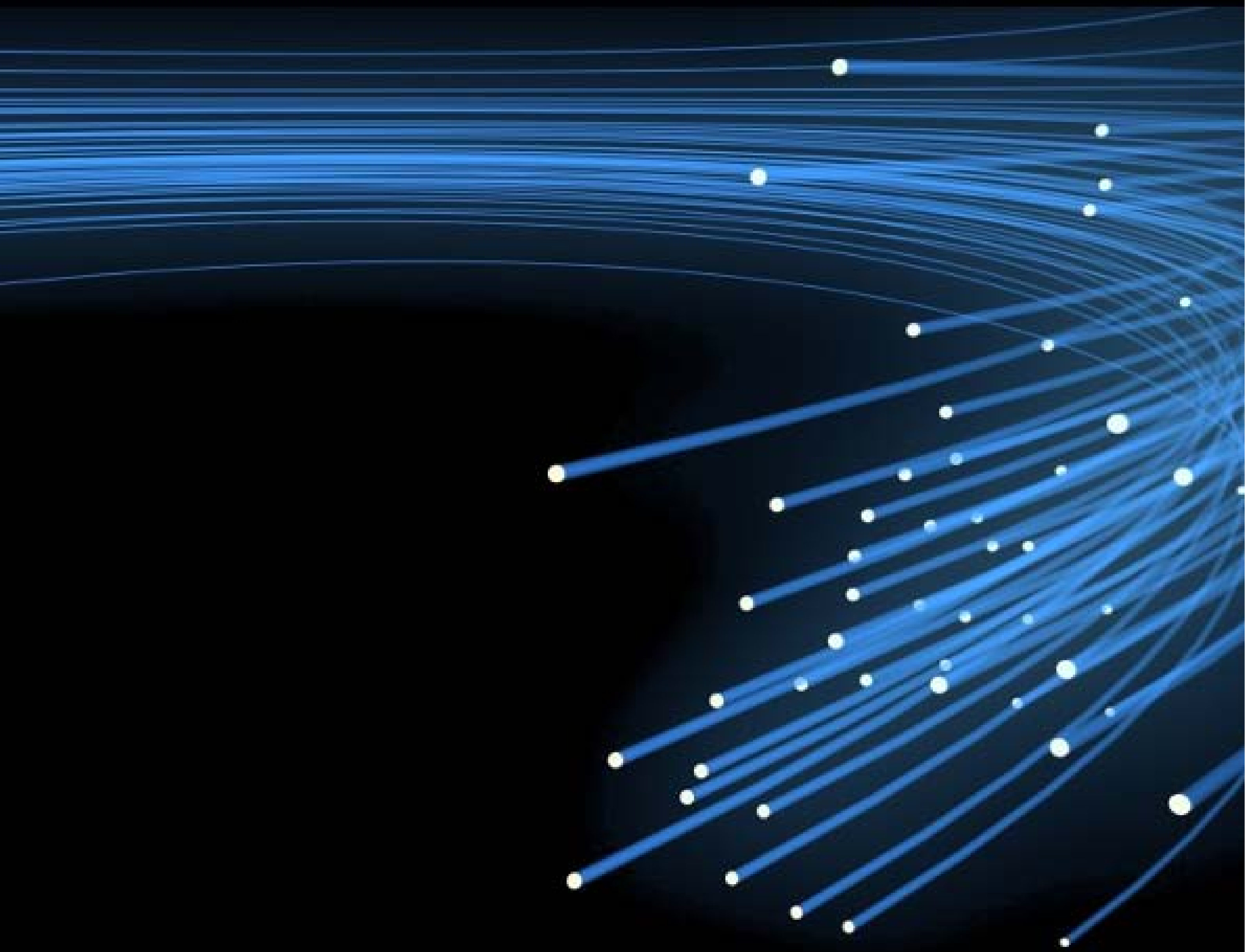
META’16 Malaga - Spain

The 7th International Conference on Metamaterials, Photonic Crystals and Plasmonics



Program

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A multi-band patch antenna loaded with composite right/left-handed (CRLH) unit cell is presented in this paper. It operates at three bands, which are not harmonically related, covering several communication standards. The first and third bands have patch like radiation pattern, the second band has monopole like radiation pattern. These bands can be controlled by varying the patch size and unit cell elements values. The performance was analyzed using both electromagnetic and circuit simulations.

15:00 - 16:00 — Sierra Nevada

Session 1A27

GEN18. Emerging applications

Chaired by: Monika Fleischer

15:00 : Sensing the surface plasmon resonance at the quantum noise limit

Karsten Pufahl, Jan Heckmann, Ulrike Woggon, Nicolai B. Grosse

Technical University of Berlin (Germany)

The mono-layer deposition of molecules onto a substrate leads to perturbations inthe local refractive index. These can be tracked via surface plasmon resonance (SPR) sensing. Weshow that the commonly-employed incoherent detection scheme (locating the intensity centroidafter Gaussian illumination) is only 86percent efficient when compared to an optimal coherent schemeoperating at the quantum-noise-limit. We derive expressions for the detectability, and advisehow the spatial modes for illumination and detection are best tailored to the SPR resonance.

15:15 : Plasmonic waveguide based mid-infrared lab-on-a-chip

Benedikt Schwarz[1], Daniela Ristanic[1], Peter Reininger[1], Hermann Detz[2], Aaron Andrews[1], Werner Schrenk[1], Gottfried Strasser[1]

[1]*Institute for Solid State Electronics and Center of Micro- and Nanostructures (Austria),* [2]*Austrian Academy of Sciences (Austria)*

Dielectric-loaded plasmonic waveguides are perfectly suitable for on-chip sensingof fluids. They allow long propagation length and large mode overlaps above 96percent with a the analyte. Dielectric-loading is a alternative approach to increase the confinement of mid-infrared surface plasmons without the need for subwavelength patterning. Direct excitation and detection is realized using chip integrated quantum cascade lasers and detectors, enabling the realization of a monolithically integrated mid-infrared lab-on-a-chip.

15:30 : Metamaterial Integrated Microfluidic Terahertz Sensors

Xin Hu[1], Gaiqi Xu[1], Yaxin Zhang[2], David Cumming[3], Qin Chen[1]

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By constructing a metallic microstructure array-dielectric-metal structure, a metamaterial integrated microfluidic sensor is demonstrated in terahertz range, where the dielectric layer is hollow with the strongest electric field distribution and acts as the microfluidic channel. A record high sensitivity of 3.5THz/RIU is predicted by numerical simulation due to the confined field sensing rather than the regular exponential field sensing. Normalized the sensitivity to the working frequency, the calculated and measured normalized sensitivity is 0.55/RIU and 0.31/RIU, respectively.

15:45 : Graphene Array Antenna for 5G Applications

Siti Nor Hafizah Sa'don[1], Muhammad Ramlee Kamarudin[1], Fauzan Ahmad[1], Muzammil Jusoh[2]

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Fifth generation (5G) needs to provide better coverage than the previous generation. However, high frequency and millimeter wave experience penetration loss, propagation loss and even more loss in energy for long distance. Hence, a graphene array antenna is proposed for high gain to cover the long distance communications since array antenna enables in providing more directive beams.

Plasmonic waveguide based mid-infrared lab-on-a-chip

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Abstract— Dielectric-loaded plasmonic waveguides are perfectly suitable for on-chip sensing of fluids. They allow long propagation length and large mode overlaps above 96% with a the analyte. Dielectric-loading is a alternative approach to increase the confinement of mid-infrared surface plasmons without the need for sub-wavelength patterning. Direct excitation and detection is realized using chip integrated quantum cascade lasers and detectors, enabling the realization of a monolithically integrated mid-infrared lab-on-a-chip.

Mid-infrared spectroscopy is an extremely powerful and versatile technique. Sensors based on plasmonic resonances have been shown to strongly enhance the interaction with the analytes. Different to plasmonic resonance spectroscopy, here, the analyte is probed through the change of the absorption through the evanescent field that penetrates into the analyte. In dielectric waveguides, this evanescent tail is only a fraction of the mode, while in surface plasmon waveguides the major part (98-99%) can interact with the analyte. Different to the visible and near-infrared, SPPs at mid-infrared frequencies have very long propagation length of several ten millimeter due to the larger conductivity. However, this also goes with larger penetration into the dielectric such that the SPPs are only very weakly bound. In order to overcome this issue, we use the concept of dielectric-loading. Dielectric-loading is already known from visible and near-infrared plasmonics [1], where the additional layer is mainly used to achieve lateral guiding. In the mid-infrared, there is another much more important feature: The dielectric layer produces an increase of the effective modal index, enabling the support of well confined SPPs on noble metals [2]. Propagation properties similar to spoof plasmons can be achieved without the need for sub-wavelength patterning. In contrast to the visible and near-infrared, the dielectric layer thickness (100-300nm) is only a fraction of the mode width and the mode overlap with the surrounding fluid remains more than 96%. The strong surface sensitivity due to the evanescent nature of SPPs is interesting for surface sensitive biochemical sensing applications. The used materials are bio-compatible and might be functionalized with bio-receptors.

The excitation and detector of the SPPs is realized with quantum cascade technology. A special bi-functional design allows both emission and detection such that different parts on the chip can be used for laser and others for detectors [3]. Direct coupling between the active devices and the dielectric-loaded SPP waveguide is possible due to the same polarization and the optimized mode overlap with the etch depth and the thickness of the dielectric layer. The entire system serves as a flexible platform to realize plasmonic waveguide based single chip sensors [2]. The prototype sensor device is capable to detect water in isopropanol over a large range of concentrations in real-time with 50ppm resolution. Multiple units of such laser/waveguide/detector units can be used to probe different wavelength to address multiple chemicals.

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3. Schwarz, B. et al., "High performance bi-functional quantum cascade laser and detector," *Appl. Phys. Lett.*, Vol. 107, 071104, 2015.