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Symposium : Q

Terahertz and infrared optoelectronics: from materials to devices

15 September 2014

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start at	Subject	Num.
09:10	Welcome remarks: Antoni Rogalski Terahertz detectors : Wojciech Knap	
09:15	Terahertz excitations in HgCdTe-based heterostructures Authors : F. Teppe, M. Zholudev, M. Orlita, C. Consejo, N. Diakonova, D. Coquillat, S. Ruffenach, W. Desrat, W. Knap, S. Morozov, V. Gavrilenko, M. Potemski, M. Czapkiewicz, J. Wrobel, G. Grabecki, N. N. Mikhailov, S. A. Dvoretskii Affiliations : UMR CNRS 5221, GIS-TERALAB, University Montpellier II, 34095 Montpellier, France; Institute for Physics of Microstructures, Russian Academy of Sciences, Nizhny Novgorod, Russia; LNCMI, CNRS-UJF-UPS-INSA, 25, avenue des Martyrs, FR-38042 Grenoble, France; Polish Academy of Sciences, Institute of Physics, Aleja Lotnikow 32/46, Warszawa 02-668, Poland ISP, Siberian Branch, RAS, pr. Akademika Lavrentieva 13, Novosibirsk, 630090 Russia **Resume :** Surface states in semiconducting and insulating materials are usually fragile with respect to disorder and perturbations such as impurity scattering, many-body interactions, and geometrical effects. However, there are systems in which surface states are robust due to the topology of the band structure in the material volume. A well-known example is the integer quantum Hall effect in two-dimensional systems. More recently, another type of topological invariance was predicted in materials with band inversion (semiconductor with a gap between the upper p-type and lower s-type energy bands) due to strong spin-orbit coupling . In this case, one speaks of topological insulators [2]. This kind of topologically protected surface state was first demonstrated to exist in two-dimensional HgTe/CdTe quantum wells (QWs) [3,4]. In this work, we report on a Terahertz magnetospectroscopy study of topological transitions in HgCdTe-based heterostructures: i) In HgTe quantum wells with inverted band structures, we confirm that anticrossing of the zero-mode Landau levels at a critical value of the magnetic field5, is due to Bulk Inversion Asymmetry. Moreover, calculations using the 8x8 Kane model allowed us to determine the needed crystallographic orientation avoiding gap opening under external magnetic field [6,7] ii) In bulk HgCdTe at the semiconductor-to-semimetal topological transition, we have very recently used THz magnetospectroscopy to investigate three-dimensional massless electrons, called Kane References: [1] C. L. Kane and E. J. Mele, Phys. Rev. Lett. 95, 146802 (2005). [2] M. Z. Hasan and C. L. Kane, Rev. Mod. Phys. 82, 3045 (2010). [3] B. Andrei Bernevig, T. L. Hughes, and S.-C. Zhang, Science 314, 1757 (2006). [4] M. König, S. Wiedmann, C. Brüne, A. Roth, H. Buhmann, L. W. Molenkamp, X.-L. Qi, and S.-C. Zhang, Science 318, 766 (2007). [5] M. Zholudev, F. Teppe, M. Orlita, et al., Phys. Rev. B 86, 205420 (2012) ; M. Zholudev, F. Teppe, M. Orlita, et al. Proceedings of IRMMW conference, Mainz, Germany 2013 [6] M. Zholudev, F. Teppe, C. Consejo, et al. Unpublished (2014) [7] M. Orlita, D. Basko, M. Zholudev, F. Teppe, et al. Nature Physics, vol. 10 p.233 (2014) add to my program (close full abstract)	I 1
09:45	Detection of THz radiation by AlGaN/GaN HEMT: non linear effect at high intensity Authors : D. But 1, N. Dyakonova 1, D.Coquillat 1, W. Knap 1, C. Drexler 3, P. Olbrich 3, J. Karch 3, M. Schafberger 3, S. Ganichev 3 G. Ducournau 4, C. Gaquiere 4 M.-A. Poisson 5, S. Delage 5, G. Cywinski 6, P. Prystawko 6, C. Skierbiszewski 6	

in electric field in the strained MCT-based heterostructure results in the spatial separation of the nonequilibrium carriers and the possibility of the room temperature detection of the IR radiation is realized. A prototype of IR detector was fabricated on the base of HgCdTe/Si heterostructure. Investigated detector operates in the middle and long wavelength spectral range. The measured value of responsivity was from ~0.5 V/W to ~4.3 V/W at 0.5 mW incident power in mid-wavelength infrared region. It was also found out that the prototype of photovoltaic detector is sensitive to CO2 laser radiation on the level of ~0.04 V/W at 1 mW laser beam power in focal spot. The detailed analysis of the detector's performance such as spectral responsivity, detectivity versus operating temperature and frequency, absorber doping and absorber composition were performed pointing out optimal working condition.

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17:40 Background donor concentration in HgCdTe

Authors : M. Pociask-Bialy 1, I.I. Izhnin 2, A.V. Voitsekhovskii 3, A.G. Korotaev 3, O.I. Fitsych 4, S.A. Dvoretskiy 5, N.N. Mikhailov 5, M.V. Yakushev 5, K.D. Mynbaev 6

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Resume : The method of background donor concentration (BDC) determination in HgCdTe (MCT) with the use of ion milling (IM) was performed.The crystal is supersaturated interstitial mercury as a result if IM, which completely annihilates mercury vacancies (own acceptors), and forms a donor complexes and centers with all the most famous acceptor impurities in MCT (As, Sb, Cu, Ag, Au, etc.). After the cessation of IM these complexes decompose even at room temperature, and after relaxation, the electron concentration adequately reflects the background donor concentration. The proposed methodology was used to study the BDC in epitaxial HgCdTe grown by molecular beam epitaxy (MBE), liquid phase epitaxy (LPE), Metal-Organic Chemical Vapour Deposition (MOCVD) in various research centres. It is shown that the lowest BDC (level 3·exp14·1/cm^3) have MBE films on Si substrates (Rzhanov Institute of Semiconductor Physics, Siberian Branch of RAS) and LPE films (JSC Research and Design Institute of Rare Materials Industry «GIREDMET»). BDC value for MBE films on GaAs substrates (various manufacturers) is significantly higher (3·exp15· 1/cm^3). Analogous BDC quantity for MOCVD films on GaAs substrates (VIGO System SA) was typical. Possible reasons for the observed features are discussed.

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17:50 Etching influence on performance of T2SLs InAs/GaSb nBn MWIR infrared detectors grown on GaSb substrates

Authors : A. Kowalewski 1, P. Martyniuk 1, O. Markowska 1, W. Gawron 1, S. Krishna 2

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Resume : Mid-wave infrared (MWIR) technology is dominated by HgCdTe and GaAs/AlGaAs intersubband quantum well infrared photodetectors (QWIP). However, in terms of performance, InAs/GaSb type II superlattice (T2SL) has shown theoretical potential to compete with HgCdTe. T2SLs InAs/GaSb technology is under development, where proper detector's architecture formation must be considered as one of the most important steps of the fabrication process. The paper presents experimental results related to chemical etching of the T2SLs InAs/GaSb with bulk AlGaSb barriers, mesa type nBn MWIR detectors. The layers presented in this work were grown on GaSb substartes in Center for High Technology Materials, University of New Mexico, Albuquerque, USA, while device fabrication process was performed at Military University of Technology. Although, we attempted to transfer HgCdTe etching solutions: Br2+C2H6O2 and HBr+Br2+H2O into T2SLs InAs/GaSb technology, H3PO4+C2H6O6+H2O2+H2O (molar ratio: 17:1:39:150) at temperature ~21°C was estimated to have optimal parameters in terms of the mesa

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