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DOTSENSE has finished the 2[nd] reporting period and significant progress has been achieved. Towards realization of quantum dot based chemical sensors for application in liquids and gaseous environments with purely optical readout (**Figure 1**), the consortium was successful in the synthesis and characterization of polar and semipolar InGaN quantum dots as well as InGaN nanodisks inserted in GaN nanowires and has demonstrated the response of the luminescence characteristics in the respective quantum structures towards H_2 in gaseous and towards pH-variations in liquid environments. Not only have these chemical responses been demonstrated in photoluminescence measurement setups, they have also been shown in a fiber-coupled sensor unit built by EADS-IW, where the luminescence is excited by a commercially available 360 nm power LED.

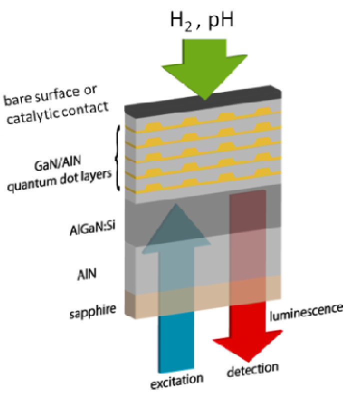

Figure 1
Schematic of DOTSENSE approach for chemical sensors: The purely optical excitation and readout of the chemically sensitive luminescence signal allows the application of simplified packaging techniques.

Technical progress

For the target applications in aerospace industries the detection of hydrocarbons and hydrogen in gaseous atmospheres as well as the detection of pH-variations in electrolytic solutions is required.

For the application in gases the optical response of $Al_{0.26}Ga_{0.74}N$/GaN nanodisks covered with a semitransparent catalytic Pt layer towards the exposition to molecular hydrogen was measured up to temperatures of 300°C. **Figure 2** shows the relative change of the ND photoluminescence intensity as a function of H_2-concentration in synthetic air for different temperatures. For operation temperatures of 300°C the detection limit is below 5 ppm.

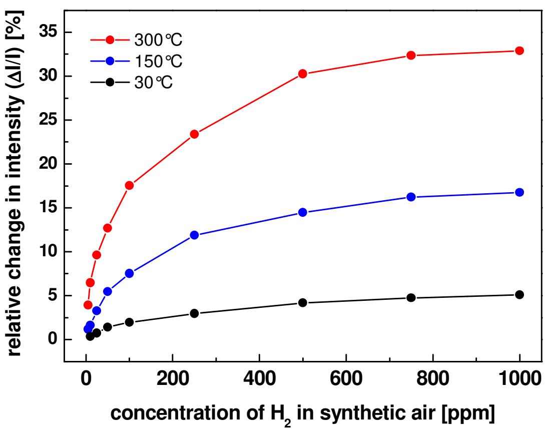

Figure 2
Response of the relative emission intensity of AlGaN/GaN NDs covered with a semitransparent catalytic Pt film as a function of the hydrogen concentration for different temperatures. At 300°C the detection limit is below 5 ppm.

For the application in electrolytes polar InGaN/GaN quantum dot superlattices were found to show a pronounced response to variations of the pH. Emitting in the range of 415 nm – 420 nm excitation with a commercial 360 nm LED as a part of the target integrated sensor system is possible. **Figure 3** shows the first pH measurement carried out with an all-optical demonstrator system, showing the sensor system output signal for different pH values of the buffer solution.

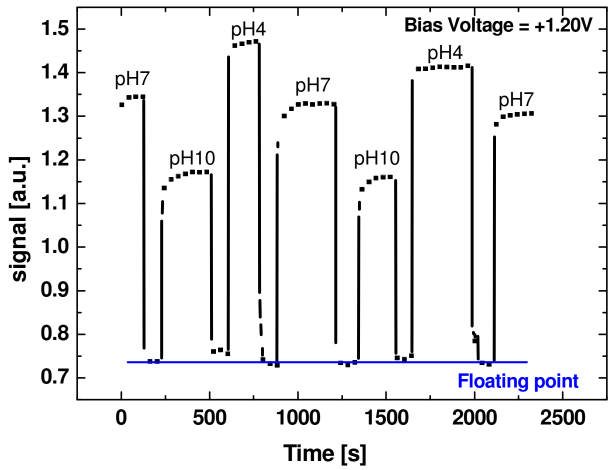

Figure 3 Read-out unit output voltage of an InGaN/GaN QD sample in different pH solutions.

After the first proof of concept of an integrated all optical chemical sensor system based on group III nitrides the last reporting period will be dedicated to an improvement of sensitivity and stability as well as an optimization of the system to meet the required specifications.

Recent Publications

"Mg doping and its effect on the semipolar GaN(11-22) growth kinetics ", L. Lahourcade, J. Pernot, A. Wirthmüller, M. P. Chauvat, P. Ruterana, A. Laufer, M. Eickhoff, E. Monroy, Appl. Phys. Lett. **95**, 171908 (2009).

"Suppression of nonradiative processes in long-lived polar GaN/AlN quantum dots", J. Renard, P. K. Kandaswamy, E. Monroy, B. Gayral, Appl. Phys. Lett. **95**, 131903 (2009).

"PAMBE growth of (112ˉ2)-oriented GaN/AlN nanostructures on m-sapphire", L. Lahourcade, J. Renard, P.K. Kandaswamy, B. Gayral, M.P. Chauvat, P. Ruterana, E. Monroy, Microelectronics Journal **40**, 325 (2009).

"Polar AlN/GaN interfaces: Structures and energetic", J. Kioseoglou, E. Kalesaki, L. Lymperakis, G. P. Dimitrakopulos, Ph. Komninou, Th. Karakostas, physica status solidi (a) **206**, 1892 (2009).

"Core models of a-edge threading dislocations in wurtzite III(Al,Ga,In)-nitrides", J. Kioseoglou, Ph. Komninou, Th. Karakostas, physica status solidi (a) **206**, 1931 (2009).

"Strain accommodation and interfacial structure of AlN interlayers in GaN ", G. P. Dimitrakopulos, E. Kalesaki, Ph. Komninou, Th. Kehagias, J. Kioseoglou, Th. Karakostas, Crystal Research and Technology **44**, 1170 (2009).

"Photoluminescence polarization properties of single GaN nanowires containing $Al_xGa_{1-x}N$/GaN quantum discs", L. Rigutti, M. Tchernycheva, A. De Luna Bugallo, G. Jacopin, F. H. Julien, F. Furtmayr, M. Stutzmann, M. Eickhoff, R. Songmuang, F. Fortuna, Phys. Rev. B **81**, 045411 (2010).

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