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Lasing and transistor properties of a single to multiple Au:SnO_2 nanowire devices made by chemical vapor deposition and electron beam lithography techniques

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Tin dioxide nanowires (typical diameter ~40 nm and lengths~ 4μm) grown on Au patterned alumina substrates by chemical vapor deposition were isolated onto fresh SiO_2/Si substrate. The isolation was accomplished by attracting single nanowires to a 200-nm glass tip under a microscope onto the Au/Ti patterned SiO_2/Si substrates as well as TEM grids. TEM confirms that the nanowires are core-shell structures of SnO_2@Au:SnO_2. When excited by electrons in the cathodoluminescence mode of SEM, these nanowires emit sharp lines (FWHM~6 nm) centred at a wavelength of around 694 nm. The width of the lines and the absence of other emission wavelengths suggest that the nanowires are acting as nano-lasers. Simple lasing mechanisms are suggested. A single nanowire device with four Au/Ti contact along its length and Au/Ti gate electrode on its side shows Ohmic resistance (~10^9 Ω and resistivity of ~) on its four contacts although the current-voltage characteristics show steps which are symptomatic of quantized conductance confirming the quantized hopping of charge carriers characteristic of the nano-scale. The drain current decreases as the gate voltage is swept from -5V to +5V in a manner expected in lateral-gate FET but revealing both enhancement mode and depletion mode of MOSFET characteristics when drain-source polarities are reversed. The transconductance is still low but this is attributed to the large gate-channel distance.

The talk will also review recent gas sensing activities with these and similar nano-structures and the issues of specificity/selectivity centred around material band gaps and operating temperatures.

Biography

Bonex Mwakikunga completed his MSc and PhD on nanowires from the University of the Witwatersrand in Johannesburg, South Africa in 2009. His post-doctoral studies around the use of lasers to manufacture nanowires were undertaken at the Council for Scientific and Industrial Research (CSIR) in the division of National Laser Centre. He is currently leading an Advanced Materials for Device Applications (AMDA) group in the CSIR National Centre for Nano-Structured Materials. He has published more than 50 papers in reputed journals, three book chapters, graduated more than seven MSc and PhD students and has more than seven collaborating countries.

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