3D Modelling of Surface Roughening Effects in Light-Emitting Diodes

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There is much interest in increasing the extraction efficiency in LEDs[1]. Many different techniques have been used ranging from surface roughening to Photonic Crystals(PhC). However there have been very few detailed studies of what constitues the ideal surface for extracting the maximum light from a structure. This paper presents results using the 3D FDTD method [2], this allows the study of specfic roughness patterns which could be etched into a structure once an optimum pattern is found. Figure 1 shows in inset the 3D model being used, the total emitted intensity is calculated in the Mid IR range which is of interest in gas sensing applications. The feature size is varied and it can be seen there is a periodic dependence up to 800nm followed by a sharp decrease. This work will now seek to find the optimum roughness for maximum light emission and then include a recycling mirror layer and compare the performance with PhC type surfaces.

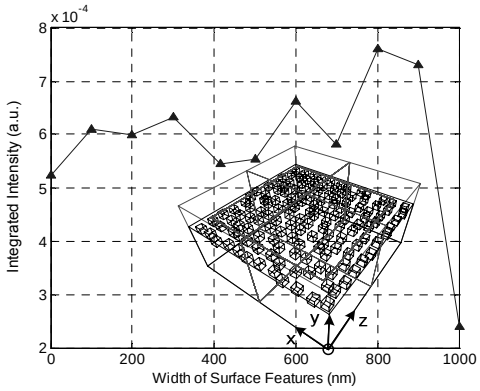

Fig 1 : Integrated emission intensity over wavelength range 2.5µm to 4.5µm

[1] N.K. Patel, *et al.*, “High-Efficiency Organic Light-Emitting Diodes,” IEEE J. Selected Topics Quantum Electron. **8**, 346-361 (2002).
[2] I.J. Buss, *et al.*, “3D Modelling of Enhanced Surface Emission using Surface Roughening,” CLEO, May 2006