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Broad Spectral Bandwidth Light Emitters for Biomedical Imaging

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Devices with high power, broad spectral emission into a single-mode fibre are of interest for applications such as fibre-optic gyroscopes and WDM testing. However, the requirements for optical coherence tomography (OCT), a 3D non-invasive biomedical imaging technique place special emphasis on spectral band-width as the depth resolution is given by the coherence length of the light source. OCT is well established in ophthalmology, oncology and cardiology, but there is a continuing hunger for broader spectral bandwidth sources.

Quantum dot (QD) hetero-structures offer a range of benefits in creating broad spectral bandwidth devices as compared to bulk or quantum well materials. Inhomogeneous broadening of the QD ensemble and state-filling give rise to broader emission. Furthermore, GaAs based self-assembled quantum dot devices are well matched to the loss minimum for skin tissue offering good depth penetration.

I will present a review of the application of QD hetero-structures manufactured using molecular beam epitaxy to the realization of broad spectral bandwidth light sources for skin tissue imaging [1]. This includes;

- The modification of epitaxial processes for increased areal QD density and inhomogeneous line-width [2, 3]
- The application of selective are intermixing [4] and selective area molecular beam epitaxy [5] to realize a spatial variation of the QD emission
- The use of hybrid quantum well and quantum dot active elements to overcome the increased degeneracy (and concomitant high current densities) of high order quantum dot states [6]
- Quantum dots for stressor modulation of quantum wells to enhance their emission bandwidth

I will go on to discuss future challenges for the epitaxy, device design and fabrication, and for high speed filters and optical components to meet the requirements of future OCT systems.

References

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