

Crosslinkable Materials for Opto-Electronic Applications

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Basic Technology Research Programme

A 1000 micro-emitters per square millimetre



Imperial College London



Introduction

Hybrid inorganic organic light emitting devices bear the potential of combining the advantages of both fields: High output power from the inorganic side and easy processability from the organic side. The development of AlInGaN micro array light emitting diodes (LEDs) readies the challenge of utilising the organic materials to the novel devices. A wide field of applications can be predicted for these type of devices reaching from micro displays to lab-on-chip¹ components.

Photo induced self alignment of the organic polymer materials offers an elegant and easy approach to the integration on inorganic semiconductor devices.

Photo curable light emitting polymer blends

We have designed a UV transparent material system² that bears vinyl ether moieties for crosslinking. The material is photo curable in the near UV and transparent down to 220nm after polymerisation.

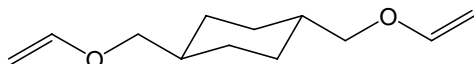


Figure 1: UV transparent material bearing vinyl ether moieties for cationic crosslinking on photo activation of a photoacid generator absorbing in the near UV.

The high transparent polymer is capable of incorporating common light emitting polymers (LEP). This way LEP become photo structurable, while keeping their solution properties (such as high quantum efficiency).

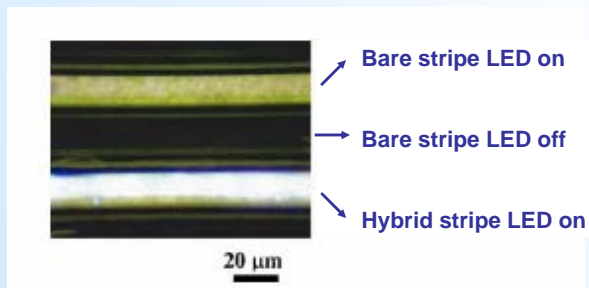
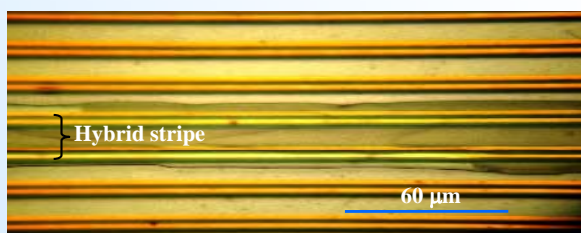


Figure 2: Photo curable polymer blend self aligned on a micro array stripe device. The top optical micrograph is showing the hybrid inorganic/organic structure. Bottom picture is a micrograph of the operating device (not true colour); showing a bare stripe LED (top) a turned off bare stripe LED (centre), and a turned on hybrid stripe LED (bottom).

We have recently shown³ that this technique enables self alignment of the organic blend onto the inorganic micro structured LED, resulting in hybrid inorganic/organic light emitting devices.

The UV transparent material is able to incorporate a range of well studied LEP to give polymer blends emitting red, green and blue (RGB) of the visible spectrum. PDPF⁴, F8BT, and PFO all absorb in the region of the near UV spectrum while emitting RGB colours.

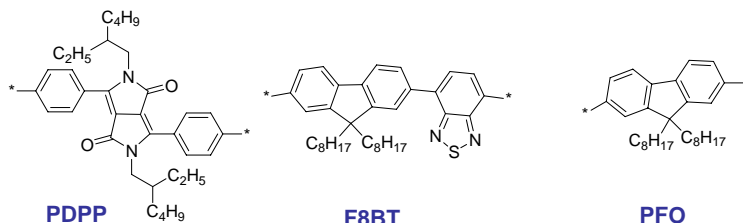


Figure 3: Photo curable polymer blends in RGB colours structured by a 5 x 5 mask with 100 micron apertures. (Under UV illumination)

Photo curable "neat" light emitting polymers

A new class of LEP has been developed that can be photo cured without using the transparent polymer matrix. This makes utilisation of the solid state properties of the LEP as well as the active incorporation of the LEP into the transparent system feasible.



An attractive feature is the incorporation of the same UV absorbing monomer unit into the backbone of all three RGB polymers so that this class of polymers absorbs at exactly the same wavelength in the near UV, emitting RGB colours by an energy transfer mechanism.

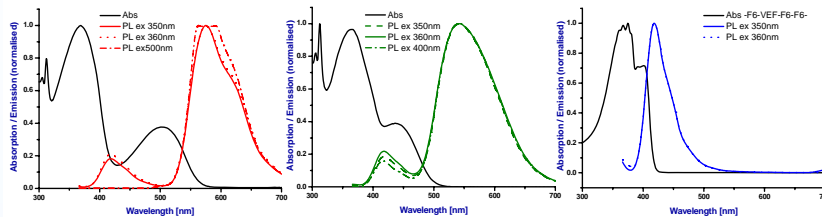


Figure 4: UV/vis spectra of the crosslinkable "neat" LEP, all showing absorption in the near UV while emitting RGB colours. (Spectra taken in solvent: Toluene or THF).

Conclusions

A photo curable material is presented that has the ability of incorporating LEP, freezing in their solution properties and making them highly efficient. Furthermore a novel class of crosslinkable LEP has been developed to be used neat or actively incorporated within the transparent material matrix. It was shown that these materials can be self aligned on inorganic micro array LEDs, making them highly efficient micro light sources in the visible range of the spectrum.

References

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