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# Modelling light extraction in 3D organic LEDs containing photonic crystals

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We discuss the modelling of light extraction in organic LEDs containing photonic crystals. These periodic structures can be placed both at the substrate/air interface and at the substrate/organic interface, but they require a different numerical treatment.

### Summary

Organic light-emitting diodes form an attractive future light source, in view of their potentially low cost, high energy efficiency and their diffuse, large-area emitting surface. However, just like any LED these devices suffer from limited light extraction because of the high-index materials involved. More specifically, light can be trapped in the organic layers or in the glass substrate. In order to improve light outcoupling, a 2D periodic structure can be placed either at the interface between the organic layer and the glass, or, several millimeter away from the emitter, at the interface between the glass and the air.

We present a comprehensive model to study light extraction from such devices. The model first uses the standard method of expanding the field of the spontaneously emitting dipole into propagating and evanescent plane waves [1]. The resulting field profile coming from the multiple reflections at the top and bottom mirror of the microcavity is then calculated. These mirrors can contain a periodic structure. The scattering properties of these gratings are calculated using the well-known rigorous coupled wave approach (RCWA) [2].

Finally, the influence of multiple reflections inside the thick substrate beneath the microcavity is taken into account by constructing a similar model, but this time using power densities rather than amplitudes in order to reflect the incoherence effects. Again, this second, larger cavity can contain a periodic structure, e.g. a grating at the substrate/air interface, i.e. on the other side of the substrate as compared to the emitting layers.

We will present the numerical details of this model, discuss the results of various device optimizations, and also show comparisons with experimental results.

### Acknowledgements

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### References

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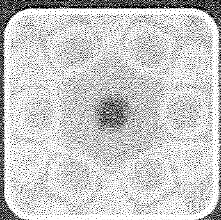

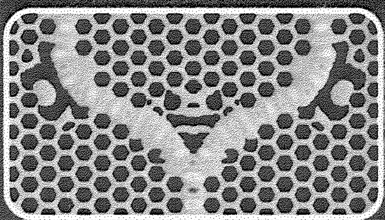

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