ELS-XV-2015 Abstracts
ELS-XV-2015-131
Electromagnetic & Light Scattering XV 2015, Leipzig

Scattering calculations for particle layers embedded in a thin film system: Coupling radiation to bound modes in optoelectronic devices

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Scattering layers on the basis of nano particles find application in the light management of optoelectronic thin film devices like organic light emitting diodes (OLEDs) and thin film solar cells. In both cases, a coupling between far field radiation modes and waveguide modes in the thin film system is desired. In the case of thin film solar cells, the light incoupling and thereby the total absorption is enhanced, whereas in the case of OLEDs, the extraction efficiency of electromagnetic power out of the device is increased.

In order to allow for optical simulations of the involved scattering mechanisms, we have recently developed and implemented a computational scheme that enables an efficient computation of the exact scattered fields for spherical particles embedded in a thin film system. The algorithm relies on the transition matrix formalism for the scattering at the individual particles and on the transfer matrix scheme for the propagation through the layer system. For the initial excitation, three different modi can be studied: a point dipole source representing a luminescent molecule (OLED case), a plane wave (for the solar cell case), and finally, the scattering of an initial waveguide mode excitation.

We present simulation results and comment on strategies to overcome the limitation of direct N-particle simulations as an approximation to infinitely extended scattering layers.

For the scattering of an initial waveguide mode, we present a direct demonstration of coherent backscattering phenomena from exact scattering calculations. Special emphasis is put on the case of coherent coupling of energy from one waveguide mode into the other.