Improvements in light emitters by controlling spontaneous emission: From LEDs to biochips

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The need to control electron and photon motions in solids, which would in particular enable better optoelectronic devices, has driven the field of light –matter interaction for the past thirty years.

For photons, some degree of control can be provided by *geometrical optics* concepts, which are currently being used in mass-produced LEDs. A more complete control relies on *wave optics* and optical mode quantization, which be achieved in a number of ways, through microcavities of varied photonic dimensionalities (which include photonic crystals), or simpler interference systems.

We will describe our recent results on photonic crystal LEDs. It will be shown that in order to obtain a significant improvement in extraction efficiency, the structures must be fully designed, to control both in-plane and vertical modes of spontaneous emission.

The concepts used for semiconductor devices can be fruitfully applied to biological systems. Like LEDs, fluorescent DNA or protein microarrays suffer from a poor luminescence efficiency. Fluorescent spots originating from the spatially selective attachment of fluorescent species on glass surfaces mostly emit into the substrate, and the remaining light is poorly collected for detection. We will describe amplifying substrates and integrated CCD/biochips which lead to greatly enhanced fluorescence collection, translating into economies of biological material, improved detection of genes with low expression, real-time measurements of hybridization, all achieved in high-functionality integrated systems.