Dottorato di Ricerca in Fisica dell'Università degli Studi di Messina

14 Giugno 2012, ore 15.00, Aula A del Dip. di Fisica della Materia e Ing. Elettronica. V.le F. Stagno d'Alcontres 31, S. Agata, Messina

Seminar title:

ITO-free white organic light emitting diodes based on multi-cavity technology

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White Organic light-emitting diodes (WOLEDs) are promising light sources which could offer an important progress in indoor lighting, where luminous efficacy (LE) higher than 60 lm/W and color rendering index (CRI) larger than 80 are needed. Indeed using different organic stack and photonic layouts, LE larger than 30 lm/W, CRI near the limit of 100 and possibility to use lightweight flexible plastic substrates have been separately demonstrated by this class of optoelectronic devices. Nevertheless the simultaneous achievement of all these targets is still a big challenge. A promising architecture to increase the Luminous efficacy and simultaneously avoid the use of ITO is based on the organic/metallic microcavity resonators. However, this technology so far has given unsatisfactory results in terms of white color quality because the achievement of high LE needs a wavelength selective cavity, which is not compatible with a broad emission spectrum and thus high CRI. Here we propose an innovative photonic architecture, named coupled-microcavity white OLED (CM-WOLED), where two or more cavities are coupled through thin high reflective metal layers, to result in the generation of two or more electromagnetic modes sustained by the whole cavity [1]. If white light emitting molecules are inserted properly into the structure as active layer, and managing the Photonic Mode Density (PMD) around the organic emitters by changing the thickness of the organic/metal layers, all the device characteristics can be improved compared to the ITO-based devices. With our approach, the color emission, the out-coupling efficiency, and the CRI can be simultaneously optimized in the same cavity structure. This opens new pathways to fabricate a novel class of very cheap, high color quality, and ITO-free devices for the next generation of "plastic-light" sources. In particular using two complementary color fluorescent materials white color electroluminescence with CRI of 84 and LE of 15lm/W have been achieved in double cavity configuration. Using Red, Green, and Blue phosphorescent materials we have exploited three-coupled cavities to achieve an efficiency of 85 and LE of 34 lm/W and 14lm/W (15Cd/A), respectively on rigid glass substrates and flexible plastic (PET) ones. To our knowledge these results are the best performances so far reported for ITO-free OLEDs and in absolute the highest values for flexible WOLEDs. . The approach is based on an ITO-free technology, thus allowing for low cost devices and a really breakthrough towards cheap highly efficient, high color quality indoor lighting.

[1] Mazzeo, M., *et al. Shaping White Light Through Electroluminescent Fully Organic Coupled Microcavities*, Adv. Mater. Vol 22, 4696-4700, 2010.