Wet-chemical application of wavelength-shifting films for the use on RICH-PMTs

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High sensitivity for photon detection in the UV region is an important quality criterium for the photomultiplier tubes (PMTs) used in the CBM Ring Imaging Cherenkov (RICH) detector. In order to increase the sensitivity of standard PMTs, application of wavelength shifting (WLS) films on top of the photomultiplier window is an established method [1, 2, 3, 4]. These WLS films typically consist of organic molecules absorbing light in the UV region and re-emitting fluorescence photons at a longer wavelength, ideally at the maximum of spectral sensitivity of common photocathodes.

In agreement with literature [1, 3, 4], p-terphenyl (PT) was identified as a most promising molecule in an earlier study on evaporated WLS films [5, 6]. In order to facilitate the application procedure, wet-chemical application methods such as dip-coating and spin-coating, have now been tested [4, 7]. For example, different binders were evaluated, and both paraloid as well as PMMA were shown to exhibit good transmission in the interesting wavelength region. Whereas dip-coating results in films with lower homogeneity, spin-coating can lead to very smooth films. Besides the spinning frequency, the ratio between PT, binder, and solvent is most important for the film quality. As depicted in Fig. 1, both scattering and transparent films can be realized depending on the binder concentration.

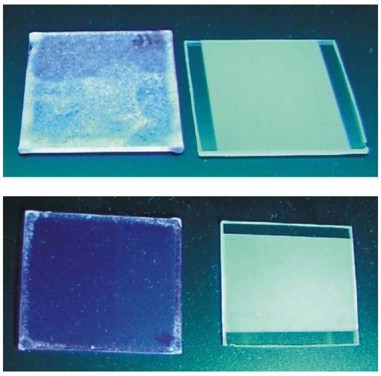

Figure 1: Influence of the concentration of binder on the morphology of spin-coated WLS films. The films are illuminated with UV-light at 254 nm. On the right hand side, an evaporated layer of 50 μg/cm^2 PT is shown as reference. Top: low concentration of binder leads to more scattering layers (1 g PT, 1 g PMMA, 41.5 mL dichloro methane). Bottom: high concentration of binder leads to transparent films (0.5 g PT, 18 g paraloid, 5.4 mL chloroform, 36 mL toluene). In both cases, the blue fluorescence of PT can be observed.

In order to check the efficiency of the wet-chemically applied WLS films, fluorescence spectra were measured of the films which were applied by means of dip-coating. The overall results are comparable to the evaporated reference layer when excited at the absorption maximum of PT at 280 nm (Fig. 2); however, some variation from sample to sample or even on one sample is observed. Similar results but with stronger variation are obtained for excitation at 230 nm, the absorption minimum of PT. Most likely, the observed variation is due to the above mentioned lower homogeneity of these films, which leads to reduced absorption in areas with lower thickness.

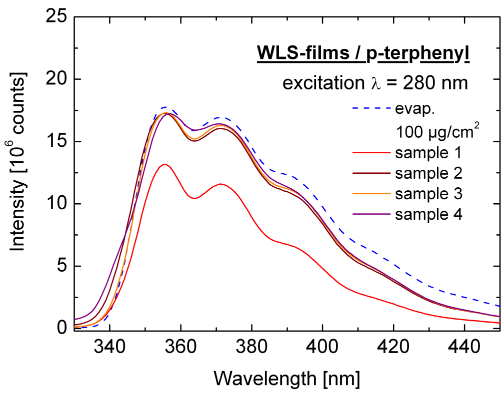

Figure 2: Fluorescence spectra of dip-coated WLS films (PT, paraloid, dichloro methane). The fluorescence intensity of the wet-chemically applied films is comparable to the evaporated reference layer. Stronger variations from sample to sample are observed, e. g. for sample 1.

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