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A plastic material with high optical transmission in the UV range.

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Abstract:

We have measured the transmission of a 25 μm thick foil of Teflon AF in the Ultra Violet region. The properties of this material allow one to use it for protecting UV sensitive materials against external contaminations.

The Dupont corporation [1] has produced a teflon-like material called teflon AF. Teflon AF is a family of copolymers which shares many characteristics of other known teflons (PTFE, FEP), but which differs greatly in the optical transmission capability. The main characteristics of this material are its low index of refraction (about 1.3) and its density of 1.8 g/cm³. Furthermore, the amorphous structure of Teflon AF compared to the semi-crystalline structure of other teflons limits the light scattering and thus favors a high light transmission from the near infrared to the ultraviolet.

We are interested in Cesium Iodide photocathodes coupled to a gaseous detector made of a multiwire proportional chamber [2,3]. The CsI photocathodes are sensitive to UV photons whose wavelength is lower than 220 nm. The quantum efficiency which can be achieved, in a pure methane gas, is about 17% at 190 nm [4]. A possible application of the gaseous photodetectors is the detection of Cherenkov light by the RICH [5] (Ring imaging Cherenkov) technique for high energy physic experiments. In some application, a large surface of photocathodes (about 20 m²) [6] is required and the detector has to operate with a good efficiency during several years. The quantum efficiency of these photocathodes is degraded when it is exposed to air or humidity [7]. Therefore we have investigated the possibility to protect the surfaces of the photocathodes with a thin film of Teflon AF. The film has to be as transparent as possible for the Cherenkov photons in our range of interest (160-220 nm). As the transmission of teflon AF was measured by the manufacturer above 200 nm, we have completed this measurement for shorter wavelengths.

A 25 μm thick foil of teflon AF has been stretched on a stainless steel ring of 2 cm diameter. We use a continuous Deuterium lamp [8] coupled to a UV monochromator [9] and a solar blind photomultiplier [10]. The whole setup is enclosed in a vessel pumped to 10⁻² Torr then filled up with pure nitrogen in order to avoid the large absorption of Oxygen and water. The anode current is measured with a picoamperemeter as a function of the wavelength when the teflon sample is located in front of the pmt. The direct current obtained without the teflon sample is measured without opening the vessel between the two consecutive measurements. The optical transmission is not corrected from the light loss due to the light reflections at the teflon-gas interfaces since we don't know the variation of the index of refraction as a function of the photon wavelength. However assuming an index of 1.3, the loss due to the reflexion is about 4%.

The result for the transmission of the 25 μm foil is shown on fig.1. A transmission of 80% is measured at 190 nm and it goes to zero at about 160 nm.

Fig.1: Measured transmission of the Teflon foil (25 microns thick)

Fig.2. shows the spectrum of the detected photons in our detector. The loss of the short wavelength photons is essentially due to the transmission in the radiator while the long wavelength photons are suppress by the photoelectron production threshold in the CsI layer.

Fig.2: Detected photon spectrum in the Fast RICH detector.

The use of the 25 μm teflon foil would modify this spectrum as shown on the figure 2 (dashed). The integrated loss of photoelectrons in the total wavelength range would be about 24%. This loss could be reduced sensibly by using a thinner foil of 10 μm which will act as an entrance window for the MWPC.

In conclusion, we have found a thin film material with a satisfactory optical transmission below 200nm. This material will allow us to protect the surface of CsI photocathodes against any air or water contamination. Many other applications can certainly be envisaged for this thin film material: it does not absorb light so it should not degrade with long exposure to light; its low refractive index makes it useful for some protective and anti-reflecting coating where optical transmission is important. However when the use of thicker samples (typically 1cm) is required, like Cherenkov radiators, the transmission needs to be improved further to be competitive with some crystals or liquids.

Acknowledgements.

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