Optical properties of "as-deposited" CsI photocathode in the VUV-UV spectral range

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Introduction

Photon detectors are one of the most complex device used in nuclear and high energy physics (HEP) experiments for particle identification (PID). The gaseous photodetectors combing a solid photocathodes are considered to be more promising, in particular with cesium iodide (CsI) photocathodes [1]. These detectors having sensitive area of the order of few m², sensitive in the UV spectral range, are successfully employed in cherenkov detectors in numerous nuclear and particle physics experiments [1–3]. Furthermore, the advantage of CsI photocathode which is sensitive in the UV regions is high quantum efficiency (QE) and can be employed in liquid scintillation cryogenic detectors [4].

Experimental Setup

Thermal evaporation technique has been used to deposit a 100 nm thick CsI film. The completed details about deposition process is described by Triloki, et al. [5].

In order to study the optical properties of CsI thin film in the spectral range of 120 nm - 240 nm, the Vacuum Ultraviolet Analytical Spectrophotometer (VUVAS) from McPherson, USA (model no. 1000) has been used. The system uses a high throughput vacuum monochromator, focused light source, a sample chamber capable of holding multiple samples, detectors, and an oil free vacuum pumping (or purge) system, see the schematic diagram of VUVAS-1000 in Fig. 1. The VUVAS-1000 directly measures reflectance and transmittance properties of Vacuum UltraViolet - UltraViolet (VUV-UV) optical components. Accurate measurement of optical properties can be made over a wide angular spread.

A schematic view of McPherson VUVAS-1000 Spectrophotometer.

Optical Properties

The optical properties of 100 nm thick CsI film have been studied in the spectral range of 120 nm - 240 nm by using VUVAS Spectrophotometer. The film has been deposited on magnesium fluoride (MgF2) substrate due to its transparency over an extremely wide range of wavelengths.

A. Optical Transmittance

Fig. 2 shows the transmittance behavior of CsI film as a function of wavelength. It

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can be noticed that the transmittance remains constant at 20-30% in the wavelength range implying the film is semi-transparent in this wavelength range. The results were compared with that of C. Lu, et al. [6] and were found to be in agreement with the results obtained there, where they too implied the film to be semi-transparent in this wavelength range.

B. Optical Reflectance

The reflectance behavior of CsI film as a function of wavelength is shown in Fig. 3. It can be observed that the reflectance is about 10% at 120 nm wavelength and remains almost constant at that in the entire range thereafter.

C. Optical Absorbance

The values of absolute absorbance were calculated form the values of reflectance and transmittance by using the relation (1)

\[ A = 100 - (T + R) \]  

(1)

It varies between 60% to 80% in the whole wavelength range. It has a short peaks at 130 nm and 140 nm. It is observed to have a dip at 160 nm, see Fig. 4.

References