CsI photocathode: New results on photon ageing.

Triloki* and B.K. Singh.
High Energy Physics Laboratory, Physics Department, Banaras Hindu University, Varanasi-221005, INDIA.
** email: triloki.bhu@gmail.com*

Introduction

In the recent years considerable progress has been made in the development of gaseous electron multiplier (GEM) based photon detector consisting a solid photocathode [1]. Cesium iodide (CsI) is known to be the best photocathode as photon converter. This is because of their higher Quantum Efficiency (QE) in Ultra Violet (UV), X-ray UV and X-ray energy ranges and their relatively high stability against ambient air and gas environment [2]. Photon detectors, which is capable of single photon counting, can reach dimension of few square meter or more and can operated at high magnetic field [3,4]. Such detectors are employed in particle and astro-particle physics experiments for particle identification using Ring Imaging CHerencov (RICH) technique. It has been observed that the QE of CsI photocathode decreases once exposed to photon irradiation and/or by exposed to humid air [5] and hence it affects the detector performance.

The aim of present work is to study the degradation of CsI photocathode by UV-photons irradiation.

Experimental Details.

The experimental setup includes a high vacuum spherical evaporation chamber. A high vacuum (of the order of 10^{-7} Torr) inside the spherical chamber was created by the means of a Turbomolecular pump. Before starting the deposition process, Cesium Iodide (CsI) powder, of 5 N purity (Aldrich Chem Co.), was melted and out gassed from a molybdenum boat under the shutter. After proper out gassing and melting, CsI photocathode was deposited onto a polished aluminum disc of 10 mm diameter. The CsI evaporation rate was 1-2 nm/sec for 500 nm thick film. After the film preparation, nitrogen gas was flushed into the chamber in order to avoid humidity and for restoring the atmospheric pressure. Immediately after the chamber opening, CsI photocathode were inserted into a vacuum desiccator and moved to the QE-measurement setup [6]. In QE-measurement setup, absolute QE measurement, before and after UV-irradiation were done.

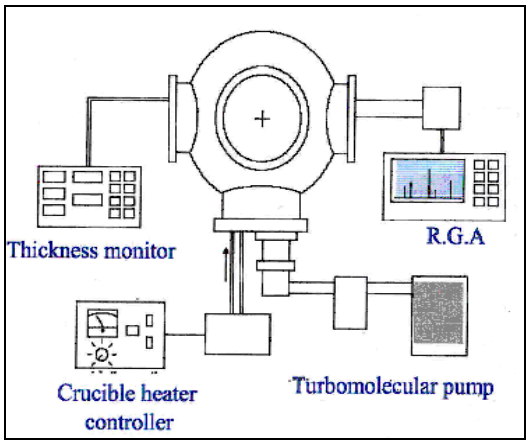

Fig: 1. Schematic diagram of CsI evaporation apparatus.

Result and discussion.

In order to study the effect of UV photon irradiation, a 500 nm "as evaporated" CsI photocathode was illuminated with 160 nm monochromatic photons. Fig. 2 shows the variation of relative photocurrent as a function of

accumulated charge. From this Fig, one can observe that after intense irradiation of UV photons, a twenty-percent loss (TPL) in relative photocurrent was observed after ~5 μC/mm^2 for 500 nm thick CsI photocathode. At the end of ageing measurement, a 90% loss in relative photocurrent was observed while the accumulated charge was ~30 μC/mm^2.

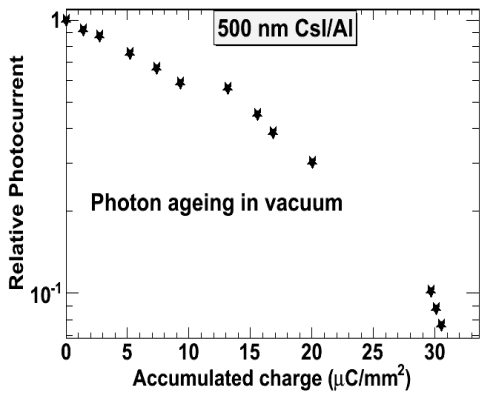

Fig: 2. Relative Photocurrent as a function of the accumulated charge during UV irradiation, under vacuum, of a 500nm CsI photocathode.

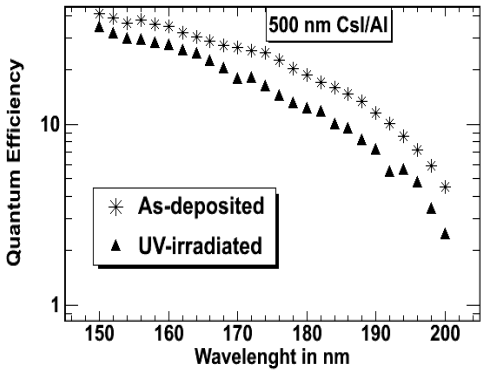

Fig: 3. Quantum Efficiency (QE) as a function of the wavelength of an "as-deposited" and "UV-irradiated" CsI photocathode.

In Fig. 3, the Quantum Efficiency (QE) of CsI photocathode before and after ageing test is displayed, which shows decrease in QE with increasing wavelength. It is observed that ageing induced by monochromatic UV photons leads to a decrease in QE at all wavelengths.

Conclusion.

We have started new R & D work on the photoemission properties of CsI photocathode, for hadron blind detector of PHENIX experiment. In this work we have presented degradation of CsI photocathode by UV irradiation. We also presented result on QE of "as-deposited" and "UV-irradiated" CsI photocathode for various wavelengths. Surface characterization of "as-deposited" and "aged" CsI photocathode will be done in future in order to understand the ageing mechanism due to photon-irradiation.

Acknowledgment.

The research work partially supported by Department of Science and Technology (DST) and Council of Scientific and Industrial research (CSIR), govt. of India.

References

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