Quantum Efficiency Enhancement for CsI Photocathodes by RSG Pre-Coating ◇

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Ring imaging Cherenkov counters (RICH) have found widespread use in high energy physics experiments for particle identification. Conventionally photon detectors used for cherenkov light registration are operated with gaseous photo converters (eg. TEA or TMAE). For high counting rates ($R \approx 10^5$ Hz) these organic vapours are not well suited because of their large absorption lengths and the resulting variation of photoelectron drift times. For such applications thin films of CsI offer a promising alternative [1], as photoelectrons released from the cathode surface will experience a constant drift time. This allows the design of photon detectors with extremely fast response and signal recovery time.

However, for an unambiguous particle identification a high quantum efficiency (QE) and correspondingly a high yield of detected photoelectrons per event is necessary. We have studied the photoelectric properties of CsI films produced in the TUM target laboratory [2] before. From these investigations [3] we concluded that the applicability of a CsI cathode in the HADES RICH photon detector might be questionable. In order to improve and stabilize the QE we optimized the production technique as well as the treatment following the production. In particular, we were interested in the influence of surface properties of the underlying substrate material. Two basic ideas were at hand:

- A smooth substrate with low microroughness would lead to a correspondingly smooth and homogeneous CsI surface and hence a minimum loss of photoelectrons due to incident angle effects [4].
- A substrate with rough surface would increase the active area and additionally lead to absorption of reflected light. Furthermore a decrease in the mean photoelectron escape lengths might raise the electron emission probability.

We have investigated CsI layers evaporated on smooth substrates (polished stainless steel, stainless steel coated with a thin gold layer) as well as on substrates with rough surfaces. For the latter we used ceramic substrates and stainless steel plates, which had either been sand blasted or coated with resin stabilized graphite (**RSG**).

It turned out that – within the errors – the *initial* QE of CsI layers does not depend significantly on substrate material or surface (see shaded part of Fig. 1). However, the CsI samples on RSG pre–coated substrate show a strong enhancement after a conditioning process. This effect is shown in Fig. 2 for one wavelength (λ = 184 nm) and is characterized by the following facts:

- The initial QE values of these cathodes are smaller compared to those of CsI layers on other substrates e.g. polished stainless steel.
- The QE is not affected by storage in high vacuum ($< 10^{-5}$ mbar) or under purified nitrogen (glove box).
- The enhancement process starts after exposure to rough vacuum (10^{-3} mbar).
- Within two weeks the QE has increased continuously up to a saturation value.

The reproducibility of the conditioning process could be demonstrated for more than 40 samples and a large area cathode used in a RICH [5]. Furthermore, a long–term stability could be observed for detector operation under methane atmosphere.

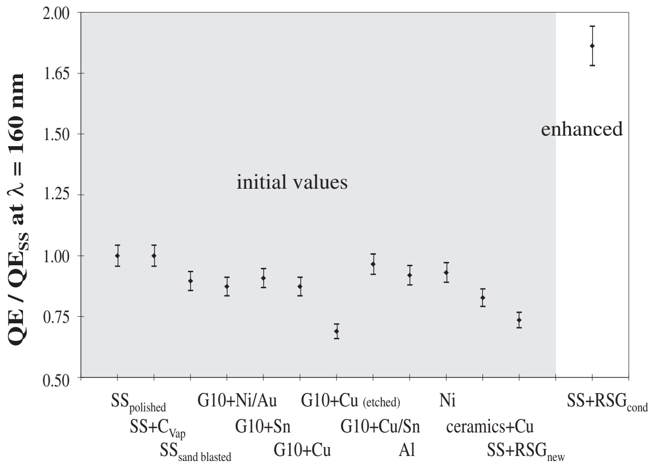

Fig. 1: Relative QE at λ = 160 nm for CsI layers on various substrates (normalized to polished stainless steel $SS_{polished}$).

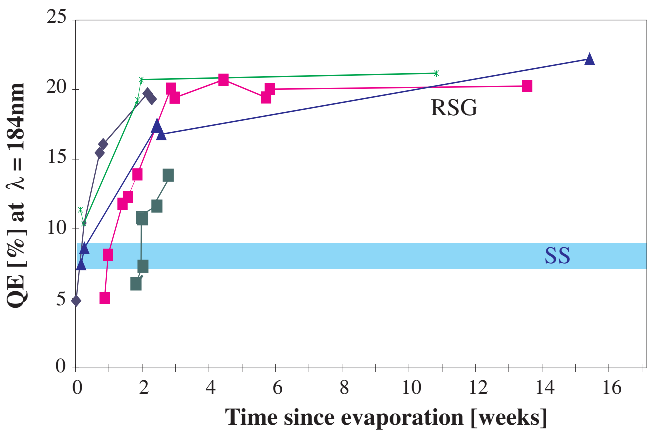

Fig. 2: QE enhancement at λ = 184 nm for various CsI samples on substrates pre–coated with RSG (shaded area: QE range for CsI samples on polished stainless steel substrates).

References

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