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DETECTION OF TOLUENE IN PROPORTIONAL COUNTER GAS
BY RESONANT TWO PHOTON IONISATION SPECTROSCOPY

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ABSTRACT

Low concentrations of toluene have been found in proportional counter gas by comparing the single photon UV spectrum of toluene with the resonant two photon ionisation spectrum of the counter gas.

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Introduction

The identification of impurities that cause laser induced ionisation in proportional gas counters is of some importance to the laser calibration programme for the large drift chambers planned for the LEP project (Raine et al 1983, Ledingham et al 1984, 1985 and references therein, Hubricht et al. 1985).

By inspection of the wavelength dependence of the two photon ionisation spectrum using a tuned dye laser, phenol has been identified as a common impurity in counter gas systems (Cahill et al 1985). Even after extensive baking under vacuum of the proportional counter and gas filling system, the laser induced ionisation remains, although at a greatly reduced level. The resonant peaks due to phenol were not present in the resonant two photon ionisation (R2PI) spectrum of the clean counter but fine structure was observed near 268nm (Fig.1). A high resolution R2PI spectrum between 262 and 269nm is shown in Fig.2.

Recently, Boerner 1985, has reported the presence of some simple substituted benzenes in standard 90% argon-10% methane gas used at C.E.R.N. These molecules often have absorption resonances in this wavelength region and investigations were made into the single photon absorption spectra of some of these molecules for comparison with the R2PI spectrum shown in Fig.2.

Experimental arrangement

R2PI spectra between 260 and 269nm were measured using a Lumonics TE 861M-3 (XeCl filled) laser which pumped a Lumonics EPD 330 dye laser. Coumarin 153 gave a wavelength coverage between 520 and 590nm. The dye laser output was then frequency doubled by Inrad KDP'B' crystals, collimated by a 1mm by 1mm aperture and passed through a single wire proportional counter. The apparatus and data acquisition system are fully described elsewhere (Ledingham 1984).

The single photon spectra for the substituted benzene samples at room temperature saturated vapour pressure in a 10cm quartz cell were measured using a Beckman UV 5270 spectrophotometer.

Results

The single photon absorption spectrum for toluene, shown in Fig.3, closely matches the R2PI structure of Fig.2.

An investigation was made of the R2PI spectrum of high purity toluene by flowing 90%argon-10%methane gas slowly over a sample of toluene held at a temperature of -80 C before entering a clean proportional counter. At this temperature the saturated vapour pressure of toluene is reported to be 5×10^{-3} torr (Handbook of Chemistry and Physics 1973) giving a concentration of about 2ppm of toluene in the counter gas. The R2PI spectrum shown in Fig.3 has the same structure as

that given in Fig.2 confirming that toluene is the main source of the residual background ionisation in the clean counter.

At 266nm the observed ionisation was 10^4 ion pairs per cm for a laser fluence of $1\mu\text{J}/\text{mm}^2$ which is a factor of about twenty lower than that measured by Bamberger et al 1985. By comparing Figs.1A and 3 the background concentration of toluene in a very clean counter system has been estimated to be 1ppb.

A preliminary investigation was also carried out on the amount of trapping of toluene by the counter surfaces to determine its suitability as a seeding agent for laser calibration systems. After flowing argon-methane with toluene at 2ppm for six hours through the counter the toluene sample was bypassed and the counter flushed with clean argon-methane. The ionisation at 267.2 nm fell to within a factor of two of the initial background in a few minutes as shown in Fig.4 and continued to fall off slowly with time.

Conclusions

Toluene is a common impurity in proportional counters, especially if methanol and ethanol have been used as cleaning agents and the C.E.R.N. experience suggests that it is an inherent impurity in argon-methane gas cylinder systems. Its ease of handling and ease of removal from counters commends

its use as a possible seeding agent in preference to previous suggestions. Further tests with toluene as a seeding agent will be carried out to determine its effect on the gas purification systems presently envisaged for L.E.P. drift chambers.

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Figure Captions

- Fig 1 Graph B shows the ionisation as a function of wavelength for a relatively clean counter while A indicates the ionisation from a counter extensively baked under vacuum. A small peak at 268nm still remains.
- Fig 2 A high resolution R2PI spectrum of conventional 90% argon-10% methane gas in a relatively clean counter
- Fig 3 The continuous curve shows a single photon UV spectrum of toluene obtained using a Beckman spectrophotometer. The experimental points (+) show the R2PI spectrum of toluene seeded into the counter at a level of 2 ppm.
- Fig 4 This graph shows the ease with which toluene is flushed from the counter by unseeded argon-methane

Fig. 1

Fig. 2

Fig. 3

Fig. 4