ULTRA-CLEAN CCD CRYOSTATS

CCD Contamination can be kept under control

S. Deiries, O. Iwert, C. Cavadore, C. Geimer, and E. Hummel

European Southern Observatory, Karl-Schwarzschild-Str. 2, D-85748 Garching, Germany

Abstract: A reproducible methodology is given to achieve ultra-clean CCD cryostats: A list of suitable materials and the necessary treatments are presented. In addition to this, the proper handling under clean-room conditions and suitable molecular sieves eliminate contamination on the detector surface in cold cryostats for years.

Key words: contamination, cleaning, CCD, cryostat, charcoal, clean-room, out-gassing, zeolith

1. INTRODUCTION

During the last years, ESO's Optical Detector Team (ODT) developed a comprehensive methodology to achieve ultra-clean CCD cryostats, because scientific results are insecure, if obtained with dirty systems. Usually, contamination first decreases the ultra-violet and blue spectral response of a CCD sensor. This phase is still invisible for the naked eye. If contamination features are visible, the resulting effect is much higher and obviously affects also the visible spectral range. In order to measure these QE changes at the telescope, the ODT built a

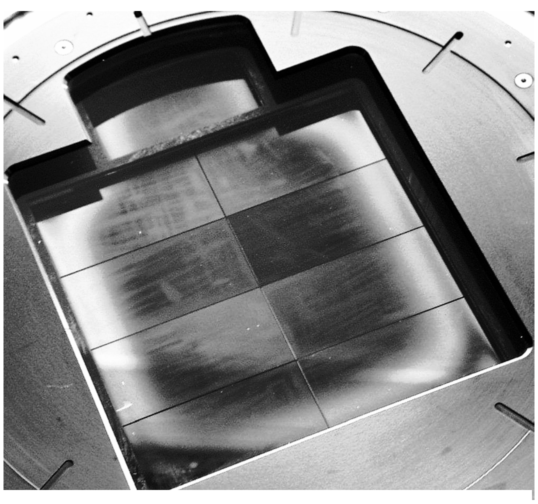
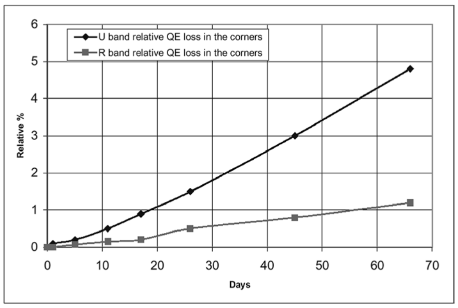


Figure 1: Contaminated CCDs

portable test bench. A reliable procedure was also developed for the ODT test bench in Garching to measure the exact degree of contamination on detectors, in order to be able to quantify that critical problem. Contamination happens under vacuum conditions because of out-gassing of unsuitable materials. If this occurs near the CCD detector, having the lowest surface temperature, unwanted condensations form at its surface. The two graphs illustrate this QE decrease:



Variation of relative QE loss over time (U band and R band).

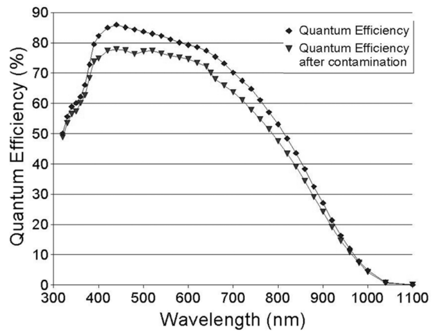


Figure 2&3: QE decrease on CCD due to contamination

2. RECIPE AGAINST CONTAMINATION

A reproducible method to avoid this hazard is now available [1]. The list of materials used in ESO's cryostats is given in Table 1. Suitable and bad materials have been obtained as a result of ESO's program of categorizing samples with a mass-spectrometer [3] and from a NASA list [2]. The procedure used to achieve ultra-clean cryostats component is given below in Table 2. First all components are hand cleaned with paper and a suitable solvent, then two times washed in an ultrasonic bath, eventually dried with pressurized nitrogen or paper and later baked in a vacuum oven to the maximum possible temperature. At last the CCD cryostat is assembled with gloves under clean-room conditions. Moreover investigations of a comparison between zeolith and charcoal, the ingredient of the cryostat's molecular sieve have been done. Coconut charcoal is the better material to prevent organic contamination. Regenerated zeolith absorbs water better. Only if the geometry of the cryostat is unfavor-

Figure 4: Cryostat assembly in clean-room

	Material, manufacturer	Curing in vacuum	Max. service temperature
Cleaning agents	Ethanol, propanol, acetone	-	40 ºC
	Tickopur-soap, Bandelin	-	85 ºC
Fiberglass	HGW 2372, Ferrozell	-	130 ºC
Glue	Master Bond EP21TCHT-1	1-2 h / 93 ºC	-269 to +204 ºC
Heating resistors	Caddock, MP821, TO-220 power package, 20 W	-	175 ºC
Internal connectors	Harwin connectors, Glass-filled polyester UL94V-0	-	85 ºC
O-ring	Viton 70A/80A, Busak & Shamban	-	200 ºC
PCBs	Kapton with copper	4 h / 120 ºC	130 ºC (250 ºC)
Ultra high vacuum grease	Fluorinated Fomblin grease: FM 090, Pfeiffer	-	100 ºC
Vacuum connectors	Hermetic connect., Hirelco Intern. connectors, Microdot	-	95 ºC
Sorption pumps	Zeolith	18 h / 200 ºC	350 ºC
	Coconut active charcoal	18 h / 20 ºC	100 ºC (?)
Thermal fuse	R&S: 176-9148	-	75 ºC
ZIF-Socket	Glass-filled polyphenylene sulfide (PPS), 3M	18 h / 105 ºC	105 ºC

Table 1: Used materials for ultra-clean cryostats in addition to stainless steel, aluminum, glass, INVAR, gold coating, oxygen free copper and electronic SMD components

able, contamination with water ice formation on the CCD is unavoidable. This happens, if a large warm surface "looks" directly at the CCD detector. Finally, a specially designed clean-room was built for the proper handling and assembly of the cleaned parts in order to get a very clean CCD cryostat. With all these measures, we have now for several years in all (kept cold) CCD cryostats at the telescopes been able to avoid contamination.

3. REFERENCES

[1] S. Deiries, E. Hummel: How ESO achieves ultra-clean cryostats, Webpage, http://www.eso.org/projects/odt/contamination/clean.html

[2] NASAs: Materials And Processes Technical Information System on the web: http://map3.msfc.nasa.gov/mapweb/page7.html
[3] O. Schütz, S. Deiries: Out-gassing of CCD components in the vacuum at http://www.eso.org/projects/odt/contamination/msreport/index.html

Material		**Washing**				**Vacuum baking (10^{-2} mBar)**	
		Possible solvent	**Hand cleaning**	**1. Ultrasonic water bath with Tickopur detergent at 80°C**	**2. Ultrasonic bath with water (80°C) or non ultrasonic bath with solvent**	**Maximum temp.**	**Min. duration**
Modified epoxy material		Acetone	no	30 min.	30 min.	120 ºC	16 h
Metals parts (Al and steel)		Acetone	yes	30 min.	30 min.	180 ºC	16 h
Electro-nic boards	ZIF-sockets	Alcohol	no	30 min.	30 min.	150 ºC	72 h
	Raw boards	Alcohol	no	30 min.	30 min.	120 ºC	72 h
	Soldered PCB	Alcohol	yes	no	no	85 ºC	72 h
CCDs	EEV	no	yes	no	no	80 ºC	72 h
	Tektronix	no	no	no	no	55 ºC	72 h
	MIT/LL	no	yes	no	no	60 ºC	72 h
Vacuum connectors		Alcohol	no	30 min.	30 min.	85 ºC	16 h
Welded inner tank		Acetone	yes	30 min.	30 min.	85 ºC	72 h
CFC inner tank structure		Alcohol	yes	30 min.	30 min.	85 ºC	72 h
Painted shields		no	no	no	no	120 ºC	72 h
Glued components		Alcohol	yes	no	no	120 ºC	72 h
VITON O-rings		Alcohol	yes	30 min.	30 min.	120 ºC	16 h
Zeolith (sorption pump)		-	no	-	-	>180ºC	16 h
Active charcoal		Alcohol	no	-	-	100 ºC	16 h
Vacuum pipes		Acetone	yes	30 min.	30 min.	180 ºC	16 h
Fittings	Vacuum valve	Alcohol	yes	-	-	120 ºC	16 h
	Vacuum gauge	Alcohol	yes	-	-	85 ºC	16 h

Table 2: Treatment of components