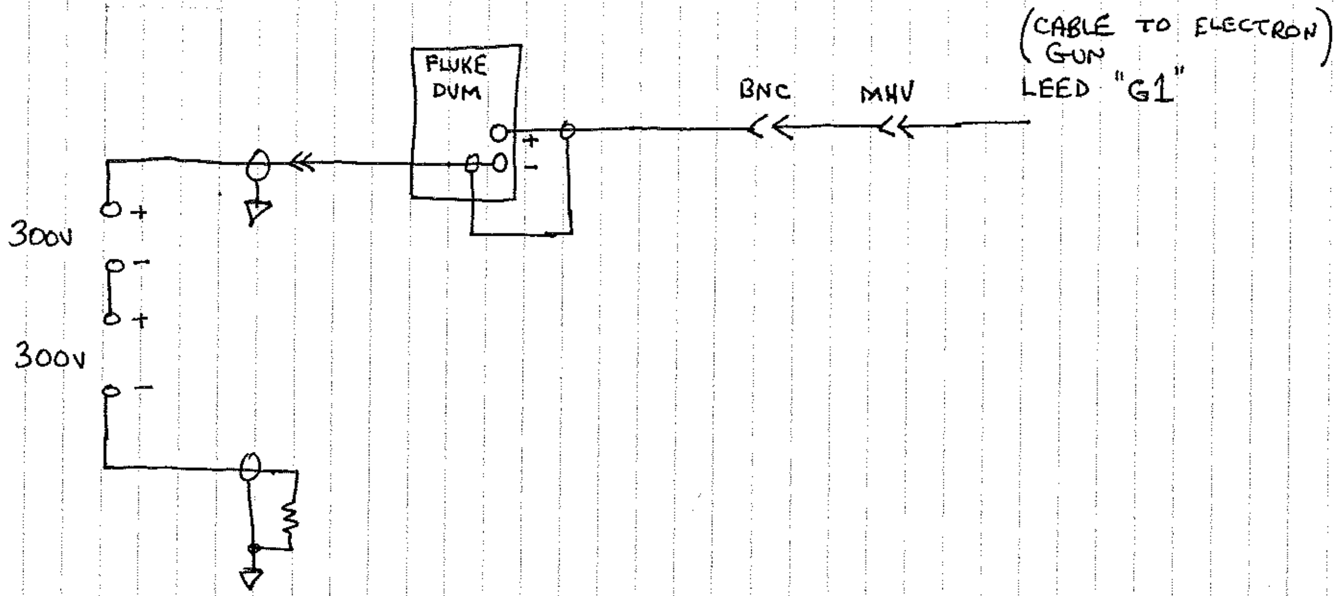
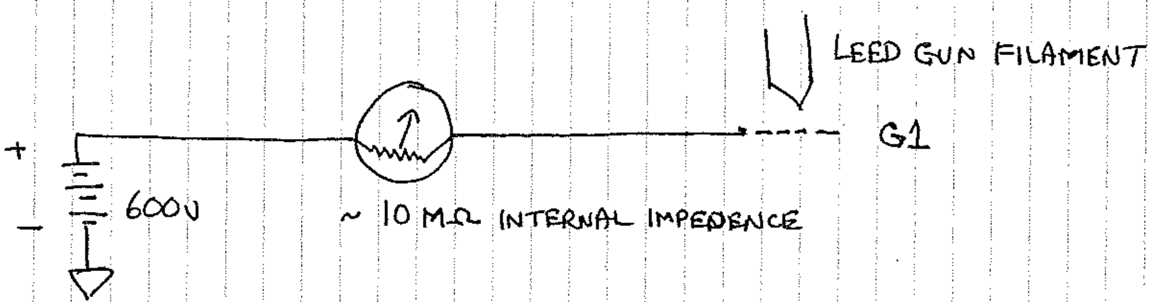
LEED GUN EMISSION CURRENT MONITOR

A SENSITIVE METHOD FOR MEASURING SMALL AMOUNTS OF EMISSION CURRENT IS SHOWN BELOW. THE ELECTRON GUN GRID 1 IS BIASED POSITIVE AT 600V TO COLLECT ELECTRONS FROM THE HOT FILAMENT. THE G1 CABLE FROM THE GUN IS REMOVED FROM THE POWER SUPPLY UNIT AND CONNECTED TO A 600V BATTERY IN SERIES WITH A HIGH SENSITIVITY DIGITAL VOLTMETER.





THE INTERNAL IMPEDENCE OF THE VOLTMETER BECOMES THE CURRENT METER SHUNT RESISTANCE AND THE EMISSION CURRENT CAN BE CALCULATED FROM

$$E = IR \qquad I = \frac{E}{R} = \frac{\text{VOLTAGE INDICATED}}{10\,M\Omega}$$

THIS IS VERY SENSITIVE AS 1mV INDICATED VOLTAGE CORRESPONDS TO 100 pA.
1 VOLT = 0.1 µA

ALL OTHER LEADS REMAIN CONNECTED TO THE LEED POWER SUPPLY.

TO BEGIN REACTIVATION OF THE FILAMENT INCREASE THE FILAMENT CURRENT UNTIL A SMALL AMOUNT OF EMISSION IS SEEN. BY TRIAL AND ERROR IT SHOULD BE POSSIBLE TO FIND A FILAMENT TEMPERATURE AT WHICH THE EMISSION CURRENT SLOWLY RISES WITH TIME. IF PURSUED LONG ENOUGH THIS APPROACH CAN BE USED TO BUILD UP USABLE AMOUNTS OF EMISSION CAPABILITY.

1-21-94
APR

REAR VIEW LEED

ALSO SEE LOG IN SCHEMATIC FOLDER

1-21-94
1-94 FILAMENT EMISSION FAILURE. WHILE IN NORMAL OPERATION OVER AN IODINE COATED SAMPLE THE FILAMENT ELECTRON EMISSION CURRENT SLOWLY FELL TO ZERO mA. SEVERAL ATTEMPTS WERE MADE TO RE-ACTIVATE THE FILAMENT BY RUNNING LONG PERIODS AT FILAMENT CURRENTS RANGING FROM 1.0 TO 3.2 AMPS. NO LUCK.

POWER SUPPLY DIAGNOSTICS: THE ELECTRIC CABLE WAS UNPLUGGED FROM THE THE LEED CHAMBER AND THE CABLE PINS LABELLED FIL WERE SHORTED TOGETHER WITH A SIMPLE WIRE JUMPER.

WITH ENERGY = 0, FILAMENT TO A1 VOLTAGE WAS 1,000V OPEN CIRCUIT. WITH A 1MΩ RESISTOR BETWEEN ONE FILAMENT LEAD (STILL SHORTED) AND A1 THE A1 VOLTAGE DROPPED TO 837V. THE LEED P.S. DVM INDICATED ~~AN~~ A SIMULATED EMISSION CURRENT OF -0.80 mA. FILAMENT TO GROUND MEASURED -2.3V.

AN AMMETER WAS CONNECTED BETWEEN THE TWO FILAMENT PINS AND A COMPARISON WAS MADE WITH THE P.S. DVM READING.

EXTERNAL FILAMENT CURRENT	INTERNAL ~~DVM~~ DPM INDICATION
0.5	0.381
1.0	0.911
1.5	1.48
1.98	1.98
2.0	2.03
3.0	3.07
3.2	3.27

WITH THE CABLE RECONNECTED THE G1 LEAD WAS REMOVED FROM THE POWER SUPPLY. THE G1 WAS BIASED AT +600V TO COLLECT ELECTRONS AND THE FILAMENT SLOWLY HEATED. A 10MΩ DVM IN SERIES WITH THE BIAS BATTERY WAS USED TO MONITOR THE LOW EMISSION CURRENT.

FIRST EMISSION SEEN @ 2.0A.

	TIME	FILAMENT CURRENT	DVM READING
21	5:30pm	+ 2.01	- 0.075
	2100	2.01	- 7.6
	1600	2.10	- 18.5
		~~2.80~~ 2.60	~~[illegible]~~ 47

1-31-94 FILAMENT CURRENT BOOSTED TO 3.25A, EXTERNAL DVM WIRED AS ABOVE READ -888. STILL NO READING ON INTERNAL DPM ~~AS~~ EMISSION.
SYSTEM VENTED TO AIR.
NEED TO DISCONNECT ABOVE DIAGNOSTIC BEFORE TRYING INTERNAL DPM AGAIN.

studied with LEED. If the electron accelerating voltage exceeds about 30 to 80 V depending on the sample, the surface discharges almost instantaneously and the diffraction pattern can then be viewed. The surface can be recharged by lowering the electron energy below a certain threshold and this cycle repeated any number of times. This threshold is clearly related to the "cross-over" well known in secondary emission.

3.2. Diffraction patterns

Having discharged the surface (or avoided charging) one obtains a diffraction pattern. In an earlier letter[4]) we had reported that diffraction patterns from vacuum cleaved mica often showed unusual spot shapes. An "ordinary" pattern consisting of round spots is shown in fig. 1a, taken from a sample cleaved in air at 1 atm. The observed hexagonal unit mesh corresponds to the known crystallography of the mica cleavage plane, as reported by Müller[5]) and also by Deville et al.[6–7]).

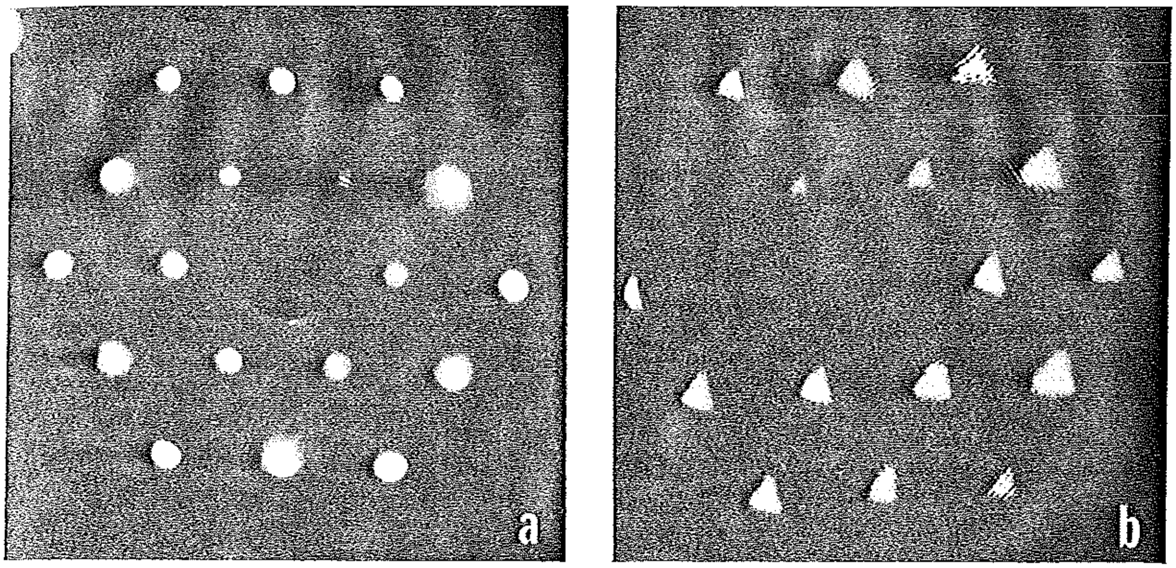


Fig. 1. Diffraction patterns from mica: (a) air cleaved, 105 V; (b) vacuum cleaved, showing triangular spots, 100 V.

Samples cleaved in vacuum showed patterns with the same unit mesh, but generally with triangular spots as shown in fig. 1b. At a given primary energy all the triangles have the same size and are similarly oriented. Besides triangles, there are three-winged stars, the wings not necessarily equally long (fig. 2a). Also the triangles are not always equilateral and can be narrow (2b). Sometimes the triangles resolve into triple spots (2c), one or even two

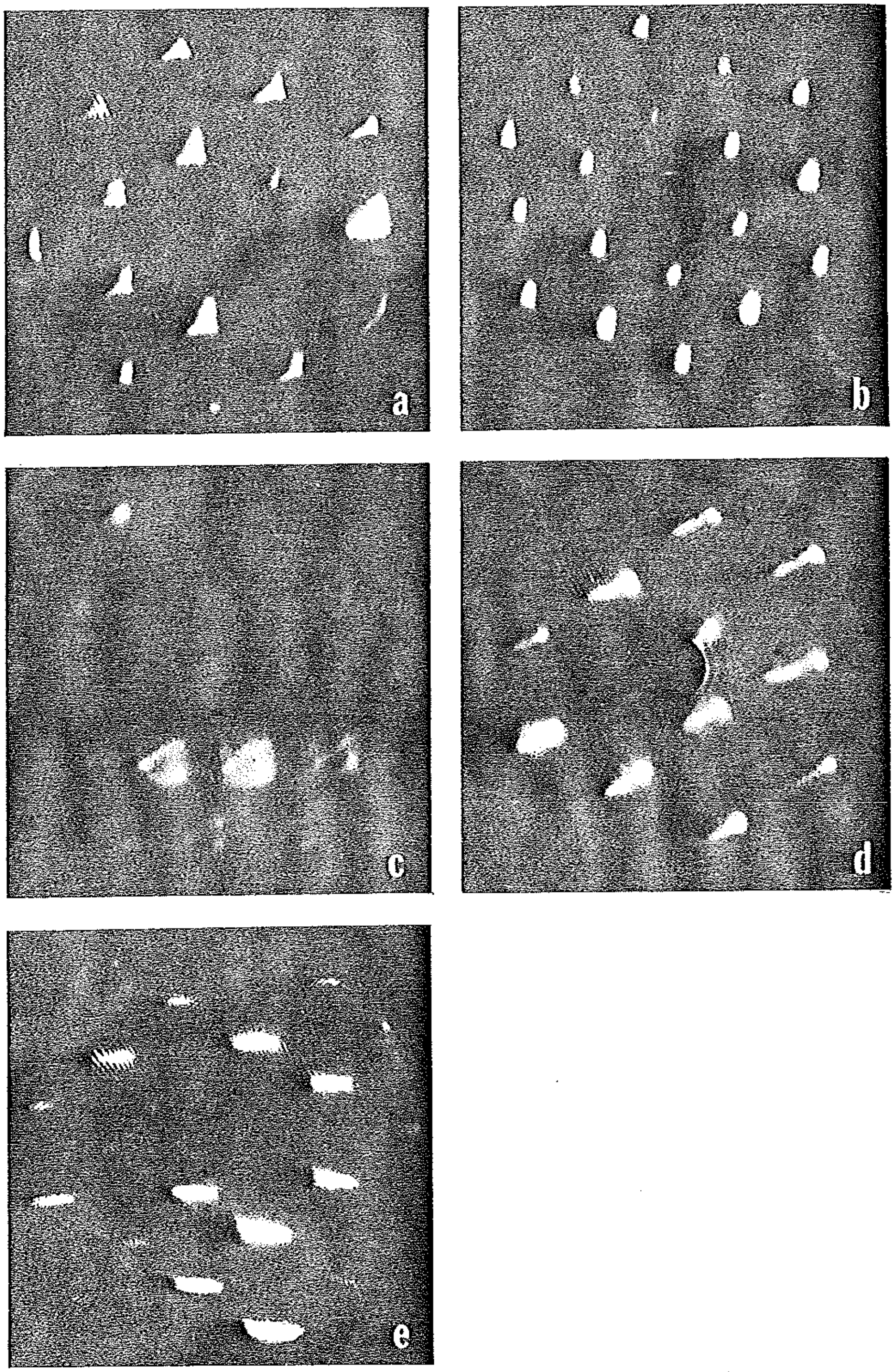


Fig. 2. Diffraction patterns from different samples of vacuum cleaved mica showing various spot shapes: (a) 60 V; (b) 100 V; (c) 66 V; (d) 50 V; (e) 120 V.

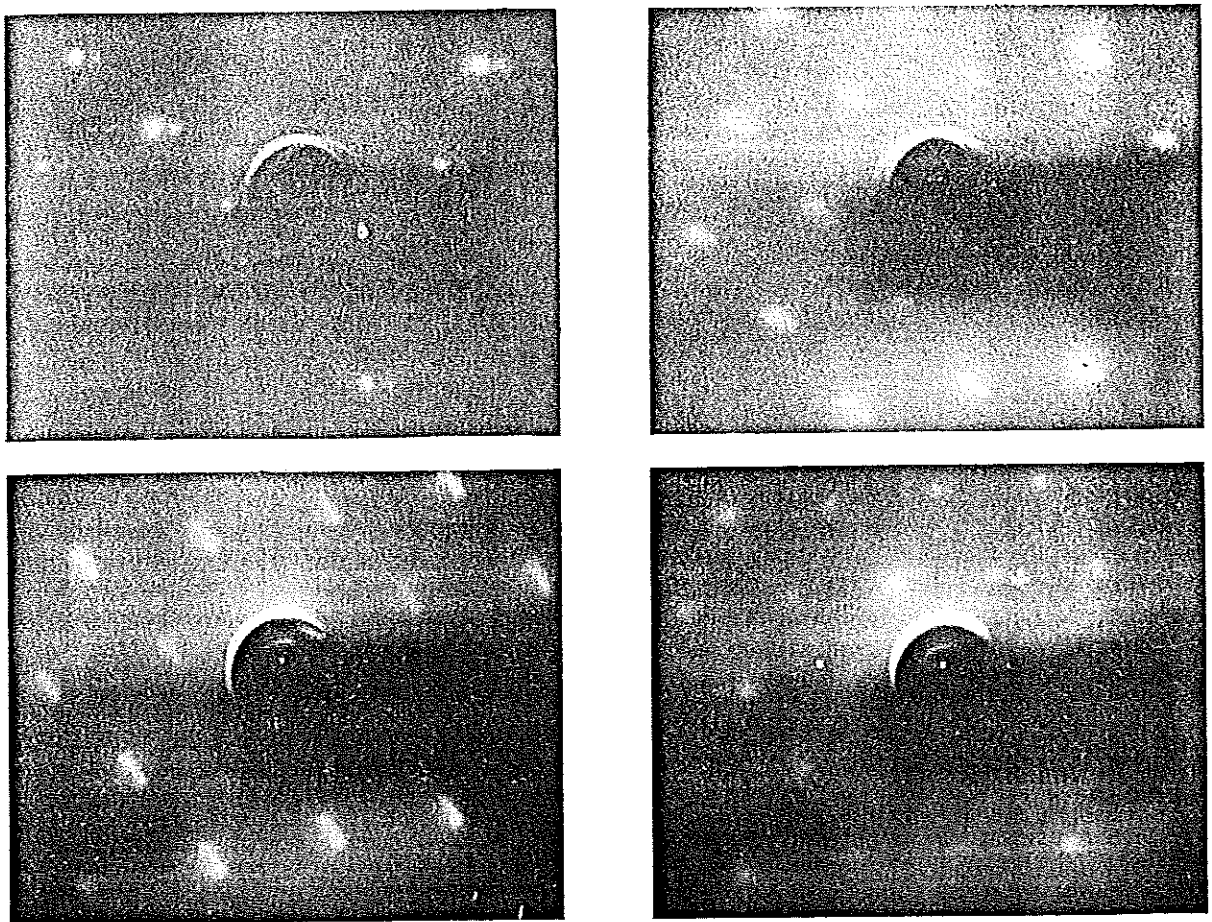


Fig. 2—LEED patterns from a mica surface cleaved in 1 atmosphere argon at beam energy (a) 90V, (b) 100V, (c) 115V and (d) 135V

LEED has not been much used to study the mica surface because of the problem of surface-charging associated with mica. However, Muller[10] and Deville *et al.*[11] did observe the hexagonal unit mesh of mica surface with LEED. Muller and Chang[7,8] found normal round spots for the air-cleaved mica surface which deteriorated and blanked out after some time. For the vacuum-cleaved surface, these authors noticed unusual patterns of triangular spots, three-winged stars, triple or double spots or streaks, all having similar orientation. The present investigation was aimed at having a closer look at the unusual LEED patterns of mica.

Materials and Methods

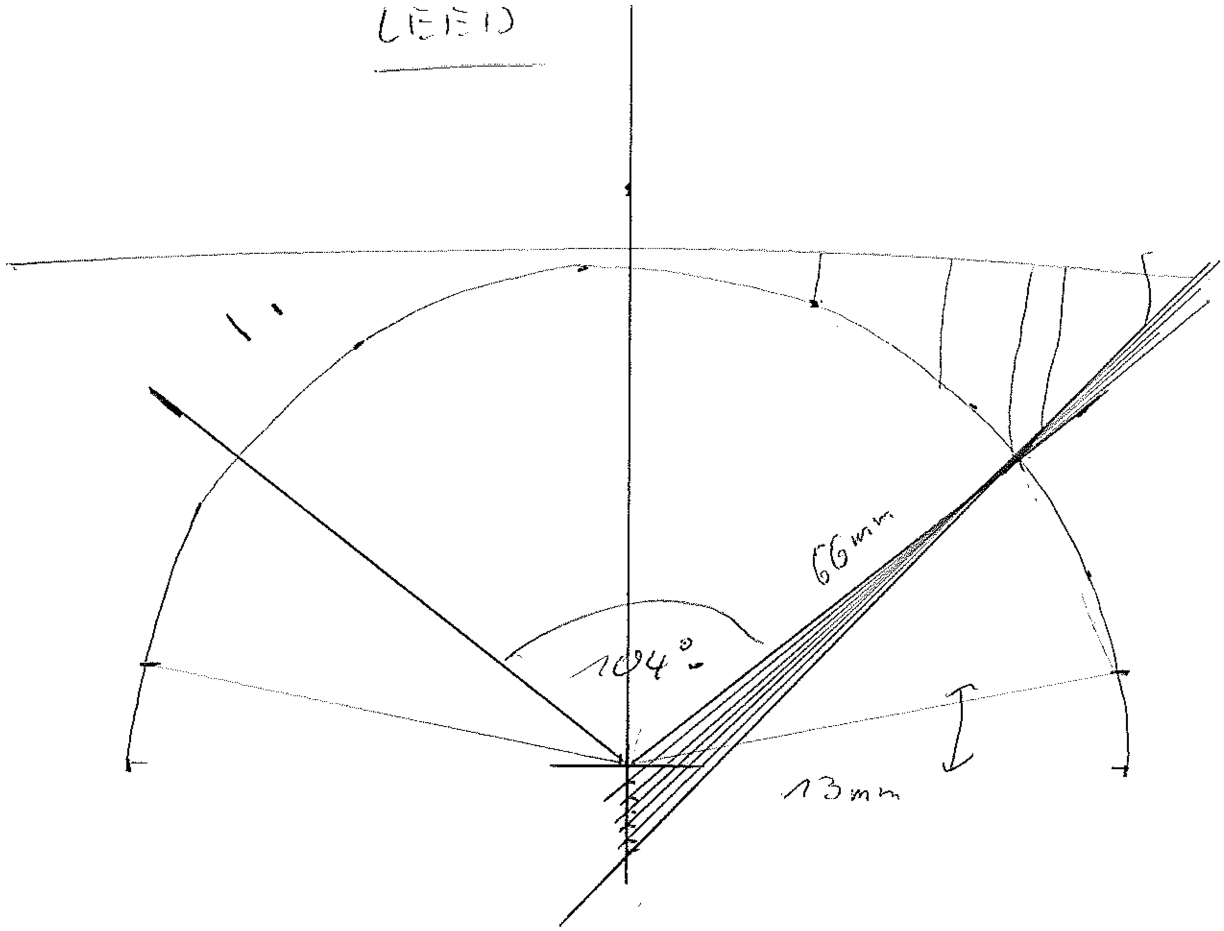
LEED patterns from mica surfaces were studied in an ESCALAB MK II system (Vacuum Generators, U.K.) fitted with LEED facility and a high precision sample manipulator in the preparation chamber. The chamber was routinely maintained at a pressure of $10^{-9}-10^{-10}$ torr (1 torr = 133.3 Nm^{-2}). One cm^2 mica samples (0.25 mm thick) were made from muscovite mica of highest purity (grade 5) and were mounted on nickel stubs with tantalum clips at the four corners. The top face of the sample could be cleaved *in situ* with a wabble stick and a small silver wire loop attached to the sample. The sample could be annealed by placing it in the P8 heating probe inside the UHV chamber.

Results and Discussion

Because of surface charging, stable LEED patterns could be seen only with an electron beam energy of 70 V or more. Good patterns were obtained with 90-150 V beam energy. The air-cleaved mica surface produced very faint patterns which could not be photographed. Annealing the surface to a temperature of 700 K did not improve the LEED patterns. The carbonaceous overlayers of the air-cleaved mica surface[12-14] could be responsible for this.

Best LEED patterns were seen when mica was cleaved in flowing argon at atmospheric pressure and the cleaved face was introduced into the LEED chamber immediately. The patterns obtained are shown in Fig. 2(a), (b), (c) and (d) for beam energies of 90, 100, 115

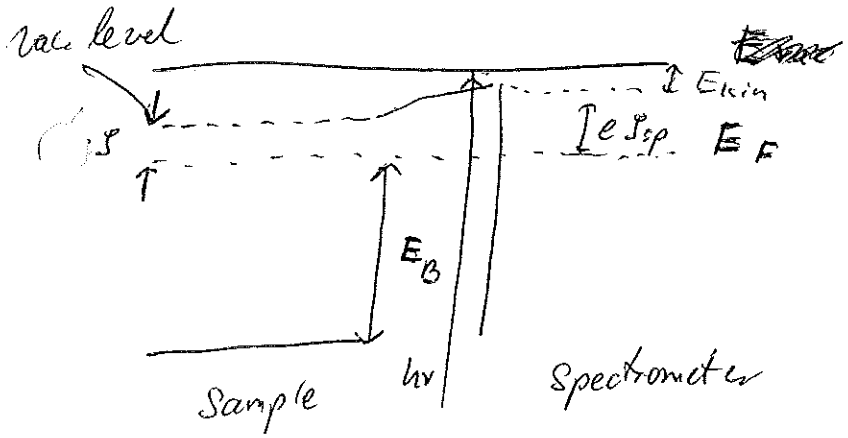
LEED



13mm optics distance	= 104°
15 mm	100°
17 mm	98°
19 mm	96°
21 mm	93°
23mm	90°
24 mm	~ 90°

∴ Ideal stub, 1.35" " has sample distance of 22mm

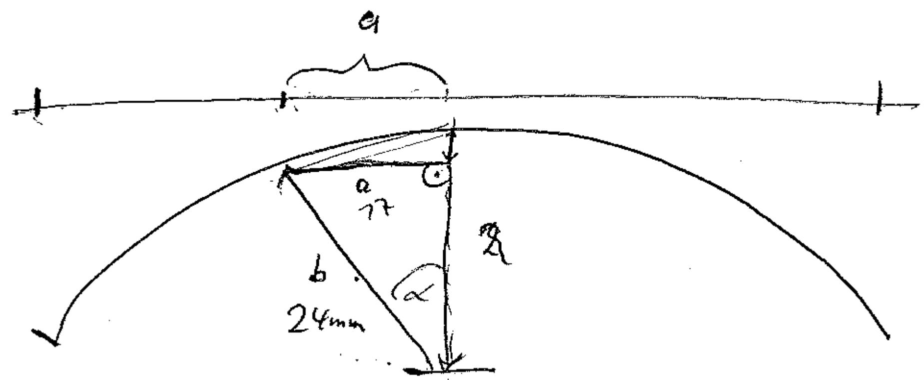
to shield end = <u>24 mm</u> to optics ≃ 90° angle full screen



In solid state measurements E_B is referenced to to E_F of the solid!

$$E_{kin} = h\nu - E_B - e\varphi_{sp}$$

work function of spectrometer



15mm ≙ 23mm

$26 \cdot \frac{15}{23} = \frac{390}{23} = 16{,}956$

26 mm	37 mm
26 mm	37

160

for b = 26

$d_{hkl} \to 0{,}102$

$\sin\alpha = \frac{17}{24} = 0{,}707 = \frac{1}{d_{hk}} \cdot \sqrt{\frac{1{,}5}{4}}$

$\alpha = 45^\circ$ $\quad d_{hk} = \frac{\sqrt{\frac{1{,}5}{4}}}{0{,}707} = 0{,}094\text{ nm} = 0{,}94\text{ Å}$

Alan 818 356 4668
4312

397 2718

Microtech

Distance sample – grid

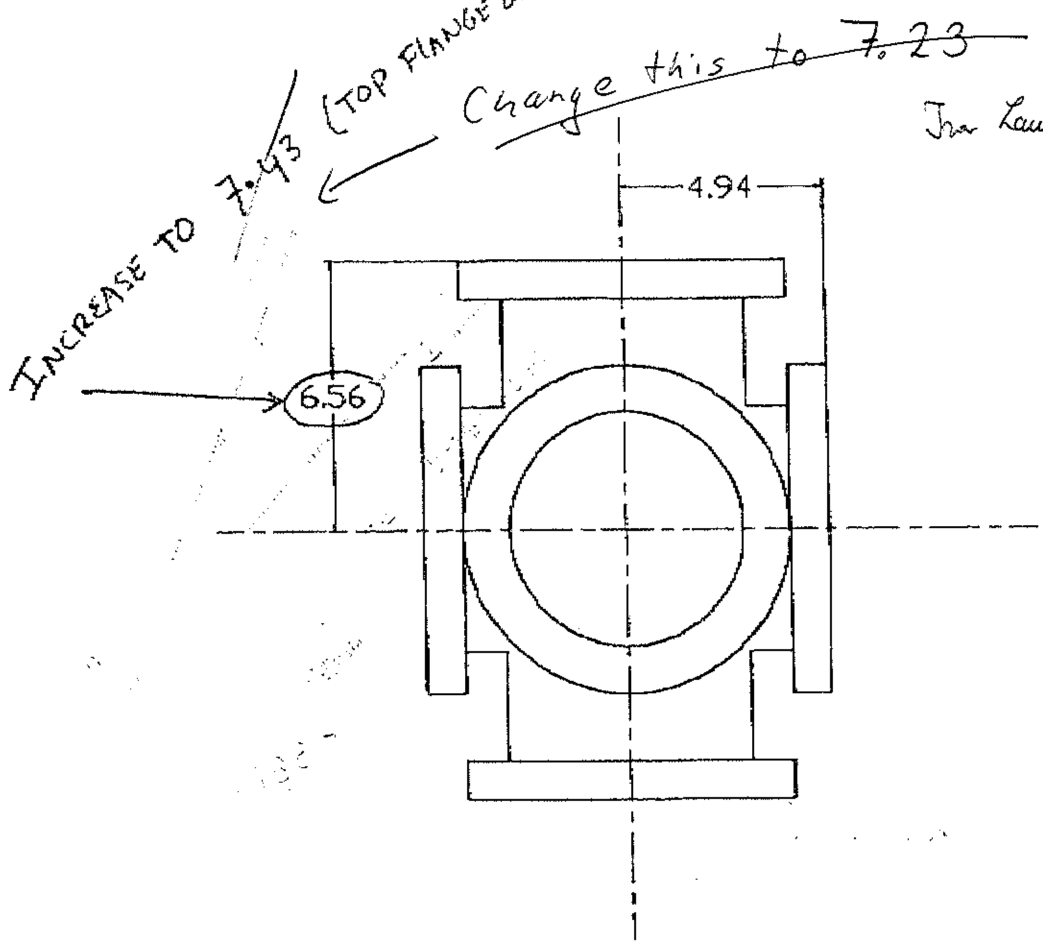
proper distance 12,2 mm – shielle
15,2 – grid
+10 = 25

closer : no more intensity
further : loose intensity
pattern moves in or out -0 → +10 mm

→ 20 mm distance to grid

.078" .87" → 23 mm
− .118"
.75" add to flange

⇒ 6,56" + .75
= 7,31"



NOTES:

1. MATERIAL IS STAINLESS STEEL (CAN BE MADE FROM 5-WAY 8" FLANGED CROSS REF. #601-5)
2. ALL WELDS MUST BE LEAK TIGHT AND VERIFIED ON A HELIUM LEAK CHECKER.

FILE HAGREG\003772_2

SEE NOTES

SURFACE SCIENCE INSTRUMENTS

TITLE: 8"FLANGE 5-WAY CROSS MODIFIED

SIZE: C | DRAWING NUMBER: 003772-00 | REV: 2

CALTECH

NEXT ASSY | USED ON | APPLICATION

7,43	188.7
− 6,56	166.6
0,87	22.10
− 0,197	− 5.0
0,673	17.10
+ 6,56	+ 166.6
7,23	183,7 mm

5 mm ≡ 0,197"

Pt target 27.4 mm HIGH
↕ ~~IDENTICAL~~
STANDARDS DISK ~ 8–9 mm ABOVE ℄

10/23/96
APR

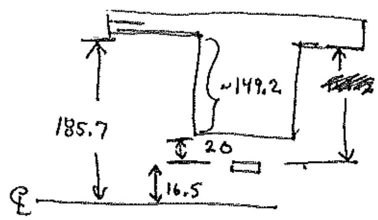
DISTANCE FROM TEE ℄ TO MATING SURFACE OF TOP FLANGE ON TEE.

MAX RECOMMENDED SAMPLE DISTANCE FOR 4 MESH LEED.

OLD @ 7.43" (188.7 mm) 1) SAMPLE TO OPTICS DISTANCE WAS 23mm
2) SAMPLE HEIGHT WAS INTERSECTION OF ION GUN + RGA AXIS.

OLD @ 7.23" (183.6mm) 1) SAMPLE TO OPTICS = 18mm

~~HENCE FLANGE TO OPTICS = 188.7~~



~~NOW @ 7.23" (183.6mm) 1) SAMPLE TO OPTICS ≈ 17.9mm~~

CURRENT @ 7.31" (185.7mm) 1) SAMPLE ⟷ OPTICS DISTANCE = 20mm from I.L.

185.7 − 20.0 = 165.7mm { FLANGE TO OPTICS SHOULD BE ABOUT 150 minimum

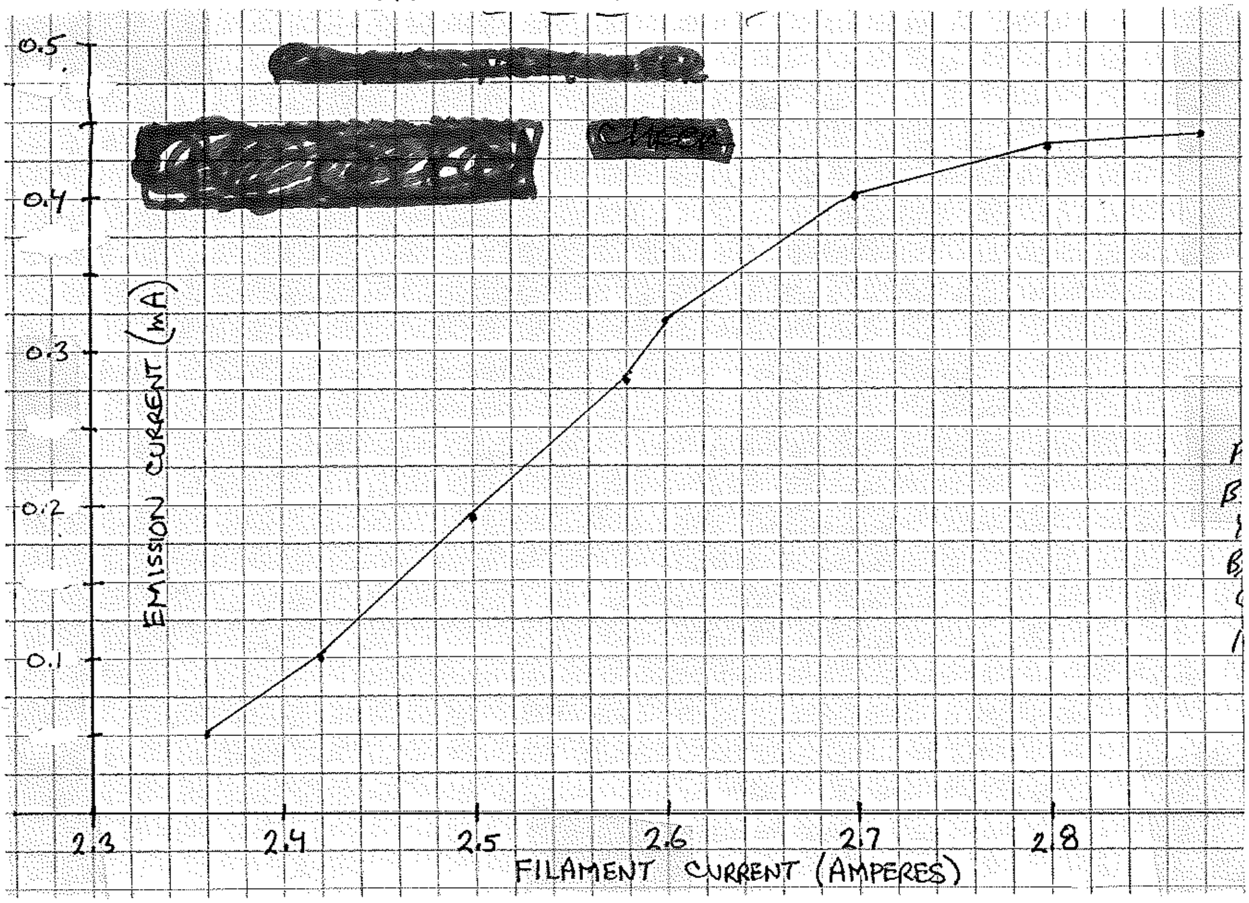
SAMPLE WAS TO BE 0.650" (16.5mm) ABOVE ℄ OF CHAMBER.

10-23-96

LEED HAS BEEN INACTIVE FOR ALMOST 1 YEAR. OUTGAS FILAMENT SLOWLY. ABOUT 6-7 HOURS TO ACHIEVE 2.2 Amps @ 2.5×10^{-9} torr (MAX 6×10^{-9} torr).

EMISSION BEGAN @ ~2.4A

FIL (Amps)	EMISSION (mA)	
2.58	0.28	
2.50	0.19	
2.42	~~1.00~~ 0.10	
2.36	0.05	
2.60	0.32	
2.70	0.40	PLATEAU
2.80	0.43	
2.88	0.44	



(2) E=900 eV

ELECTRON BEAM CAN BE IMAGED ON A PHOSPHOR SCREEN. VERY LITTLE EMISSION CURRENT (< 0.00 mA ON DPM) IS REQUIRED. UNFOCUSED SPOT IS ~ 0.4 cm DIAMETER. FOCUSED SPOT CAN BE PINPOINT SHARP VIEWED FROM OUTSIDE.