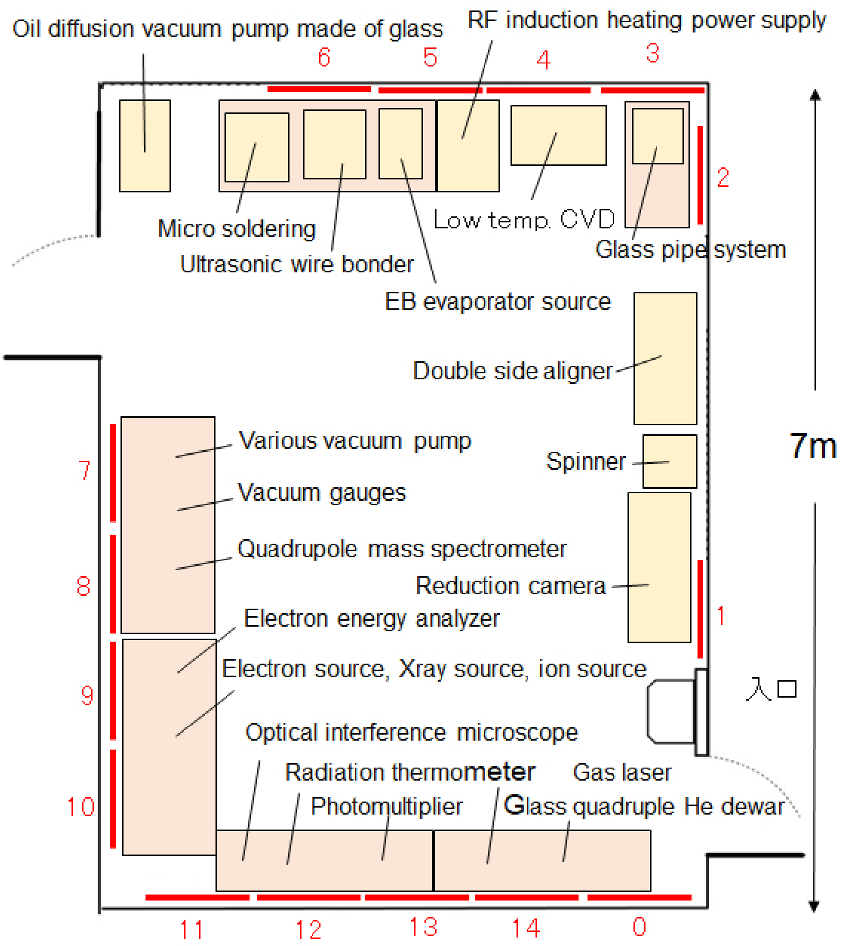
0 Mini tech museum



poster

0 Mini tech museum
1 Fabrication of photomask
2 Photoresist coating, patterning and etching
3 Wafer process (oxidation, diffusion, ion implantation)
4 Chemical vapor deposition (CVD) and RF induction heating
5 Physical vapor deposition (PVD (evaporation、sputtering))
6 Assembly (dicing, wire bonding, soldering) and test
7 Vacuum pump (rotary pump, turbo molecular pump, diffusion pump, ion pump, cryopump)
8 Vacuum gauges and quadrupole mass spectrometer
9 Xray photoelectron spectroscopy (XPS)
10 Auger electron spectroscopy (AES)
11 Optical microscope for measurement
12 Various measurement method other than optics
13 Gas laser, photomultiplier and radiation thermometer
14 A liq.^{4}He / liq.N_2 cryostat Dewer by double−

Layout of exhibition and poster

Tech museum located in San Jose (west coast USA) before was used to show the fabrication sequence for integrated circuit. Our mini tech museum shows how the integrated circuit is fabricated as well. In addition to the fabrication sequence components for equipment are exhibited.

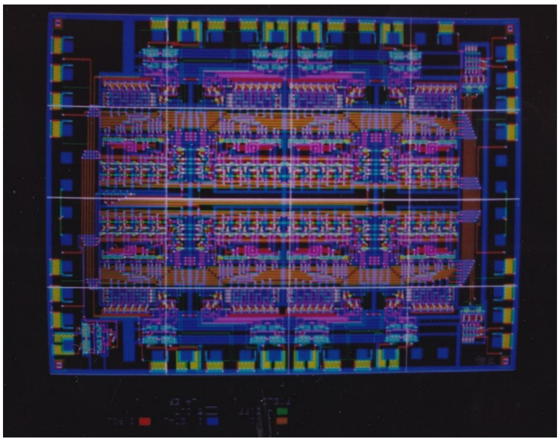
Tech museum (at present)

Mini tech museum 1

Mini tech museum 2

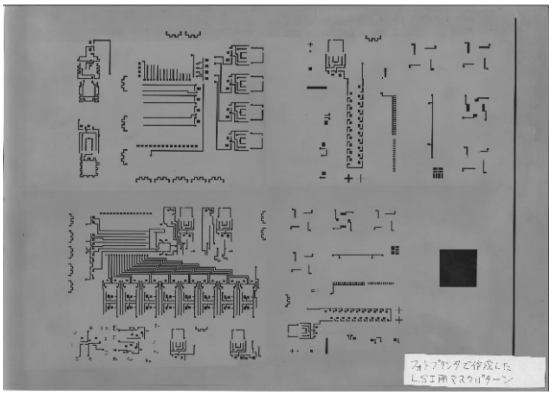
1 Fabrication of photomask

Patterning system for layout design
(Minicomputer PDP11)

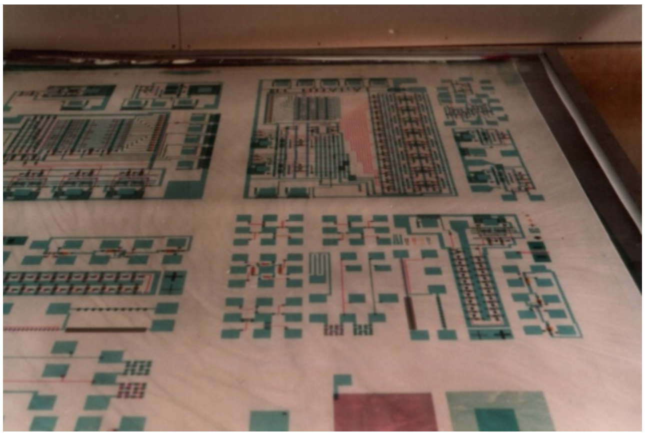


Layout (Graphic editor was made by Fortran)

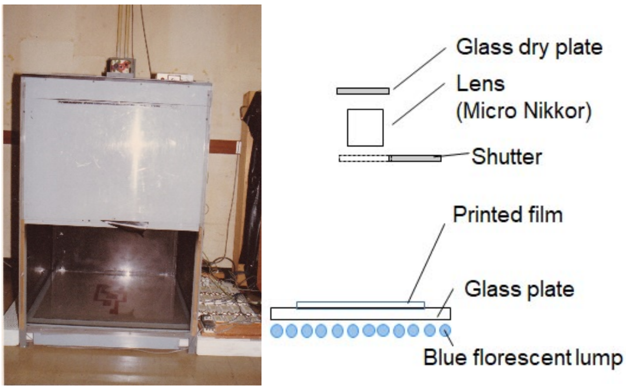
Photo printer for output



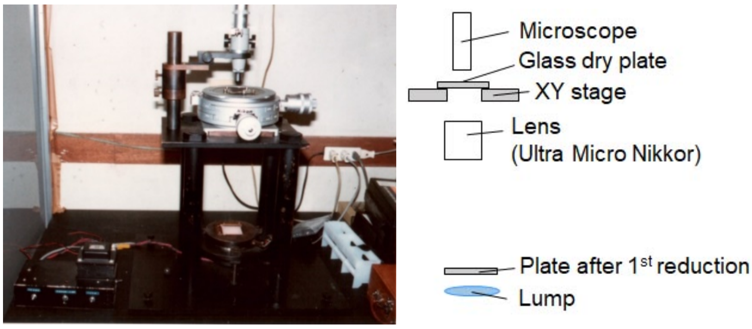
Printed transparent film



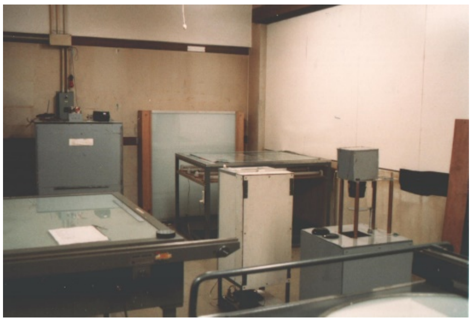
Patterns of each layers are checked



1/20 reduction camera (exhibited)

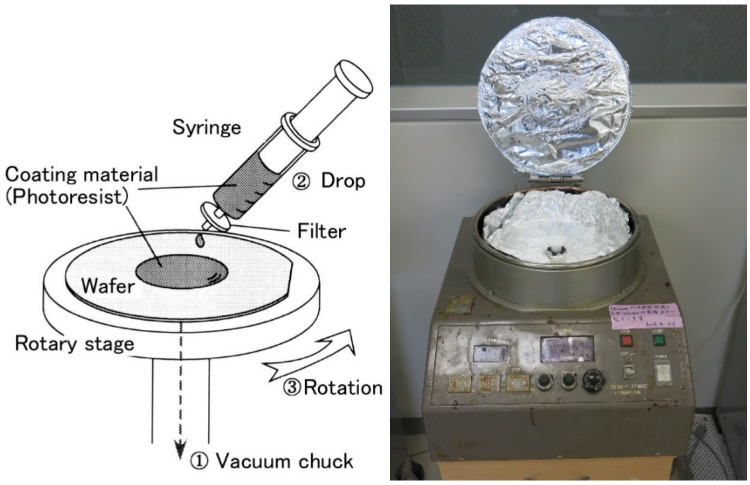


1/10 reduction camera for repeated pattern

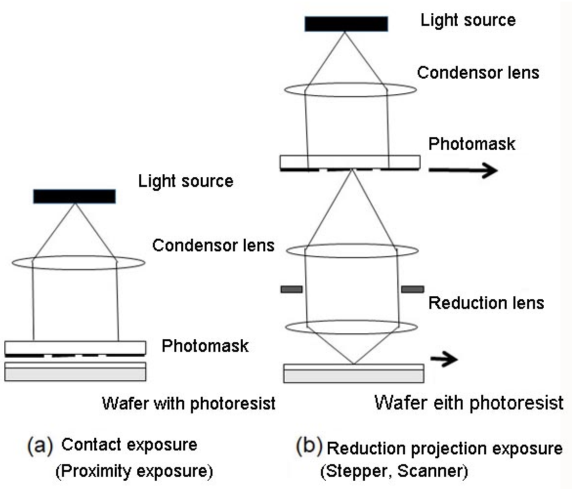


Mask making room

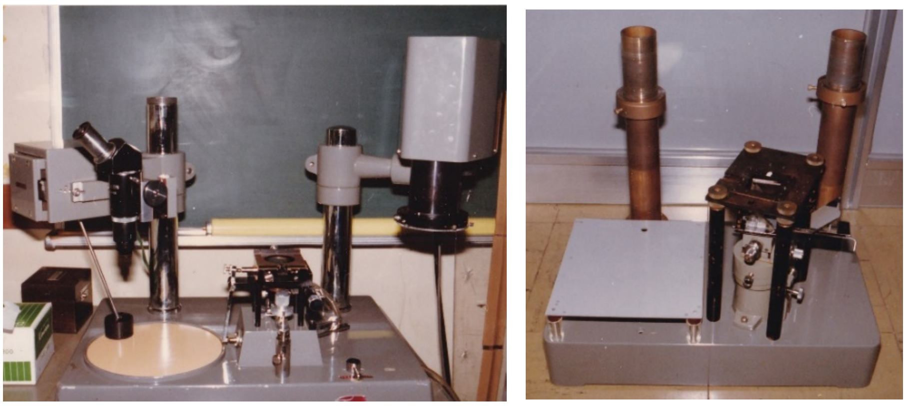
2 Photoresist coating, patterning and etching



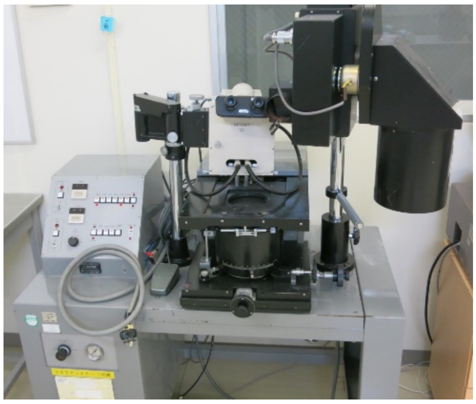
Spin coater (exhibited)



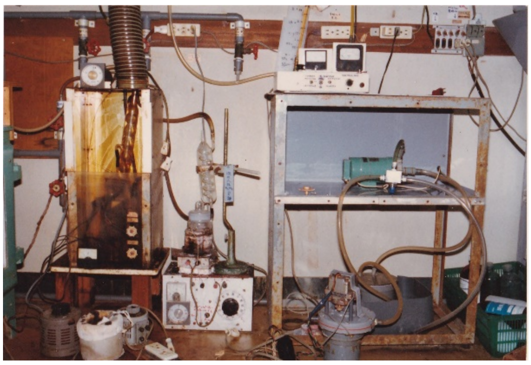
Principles of exposure systems



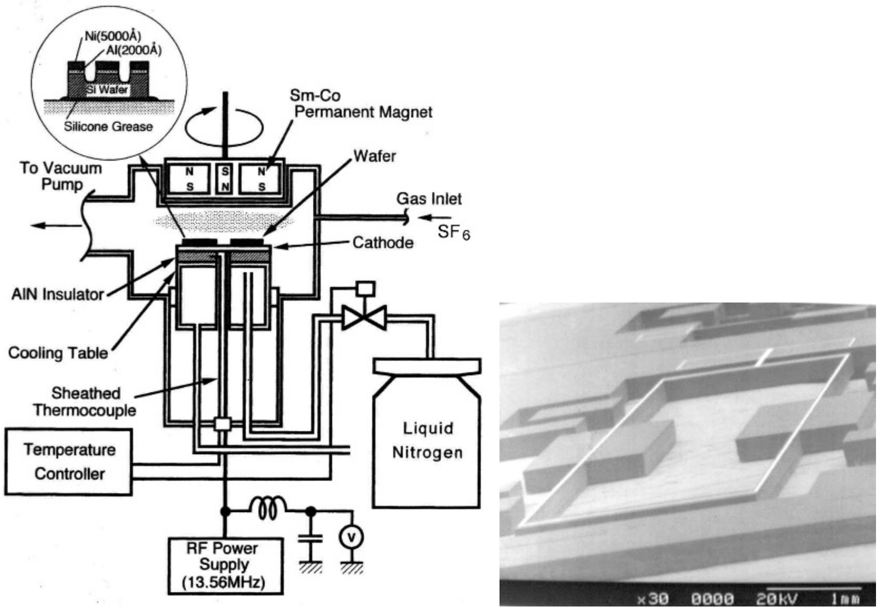
Contact exposure system and modified double side system



Double side exposure system (exhibited)

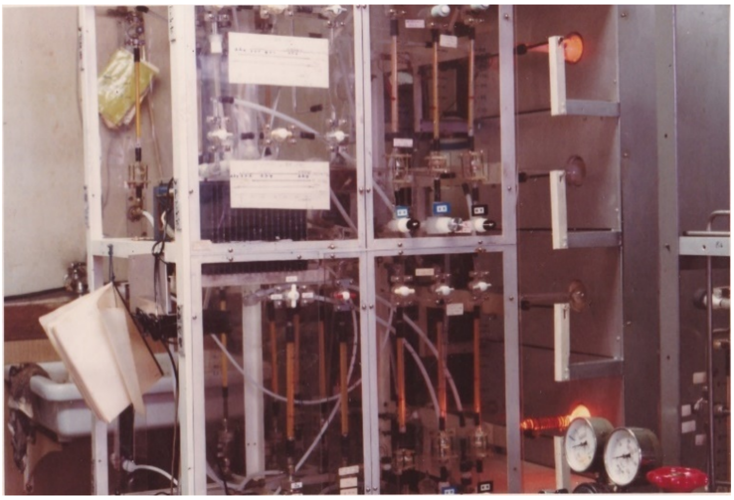


Wet etching (Si_3N_4)



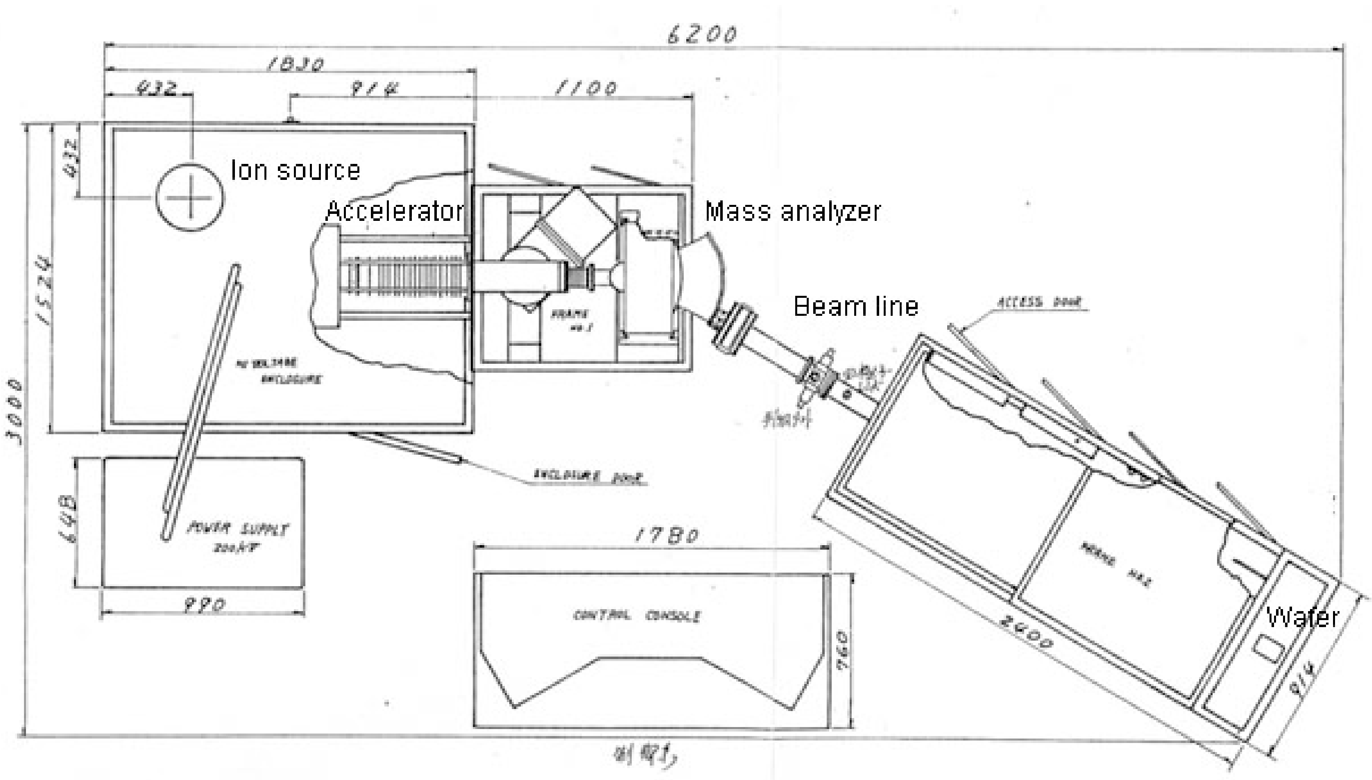
Dry etching (Si reactive ion etching (DRIE))

3 Wafer process (oxidation, diffusion, ion implantation)



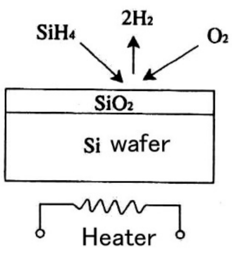
Oxidation diffusion furnace (Liquid source BCl_3, $POCl_3$)

Glass pipe line (exhibited)

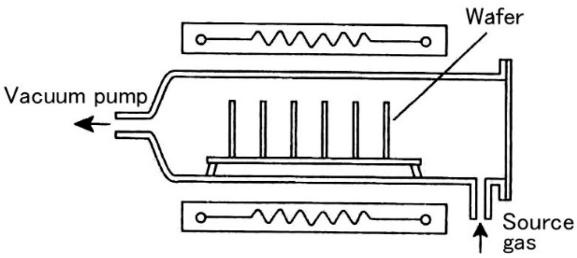


Ion implanter (Accelerator Corp. 200kV)

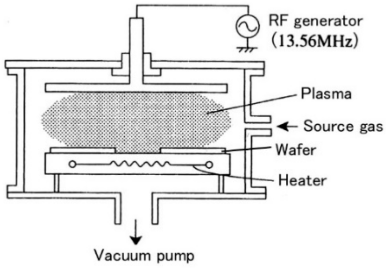
4 Chemical vapor deposition (CVD) and RF induction heating



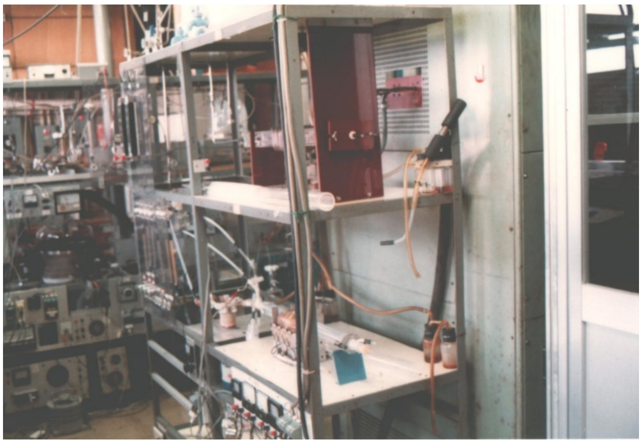
Principle of chemical vapor deposition



Low pressure (LP) CVD

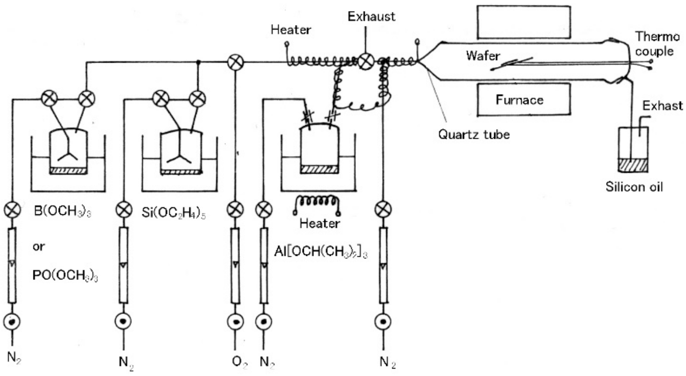


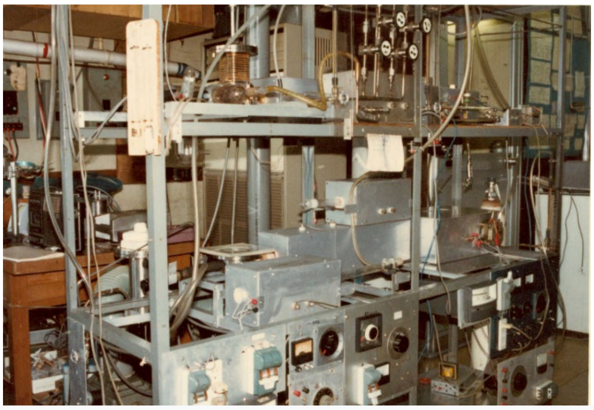
Plasma CVD



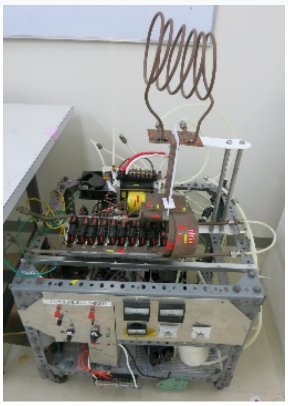
RF heating poly Si, SiO_2 CVD (top)
Infrared heating Al_2O_3, Ta_2O_5 CVD (bottom)

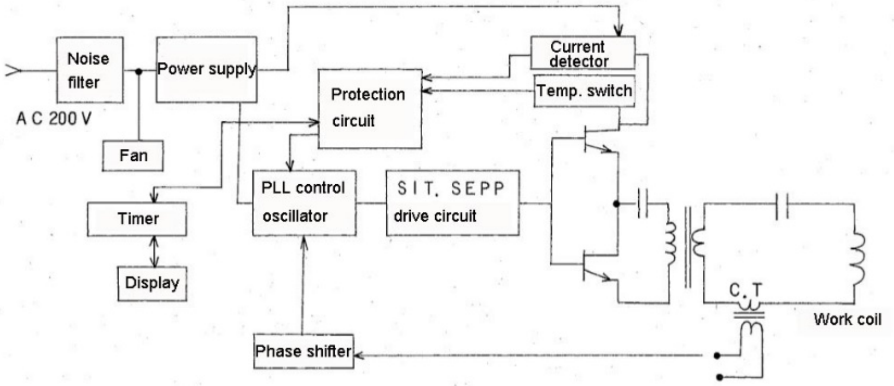
Low temperature SiO_2CVD (exhibited)





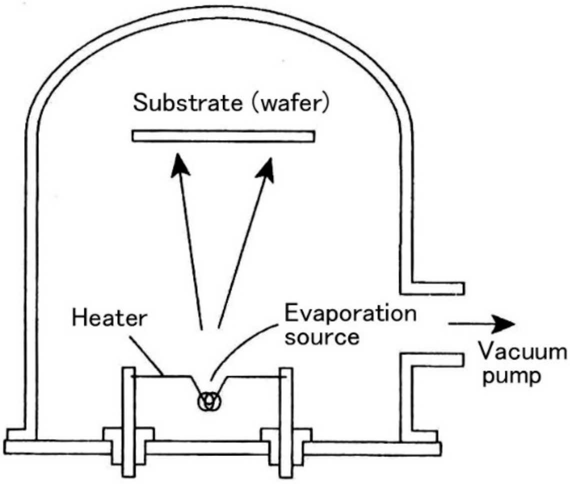
Organic liquid source (Tetraethoxysilane TEOS etc.) P_2O_5–SiO_2, B_2O_3–SiO_2, Al_2O_3–SiO_2 CVD



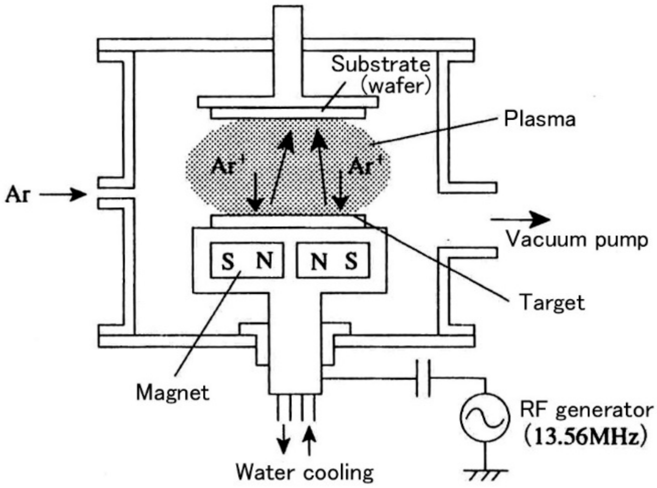


Oscillator for RF inductive heating using SIT (static induction transistor) (Tokin)(exhibited)

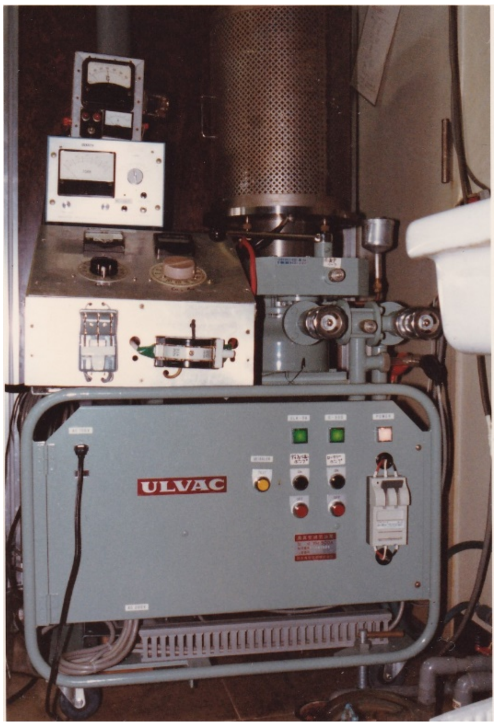
5 Physical vapor deposition (PVD (evaporation、sputtering))



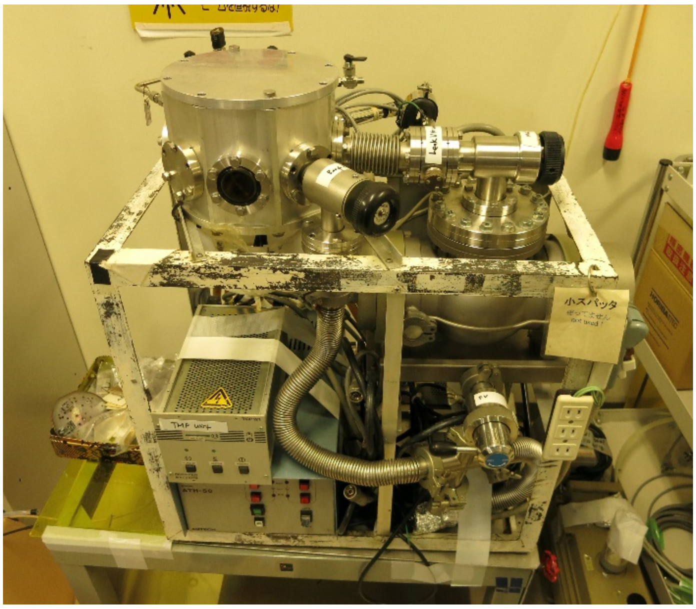
Principle of evaporation



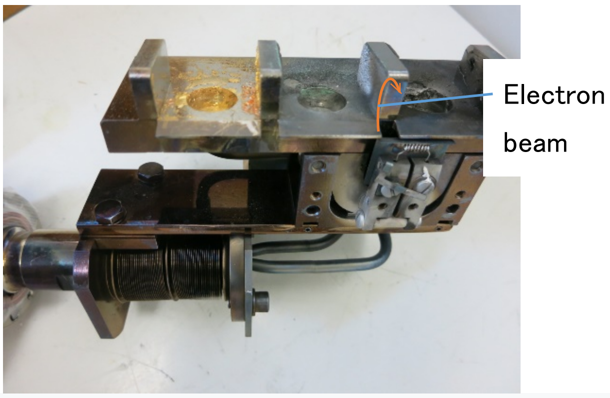
Principle of sputter deposition



Evaporator



Sputtering machine



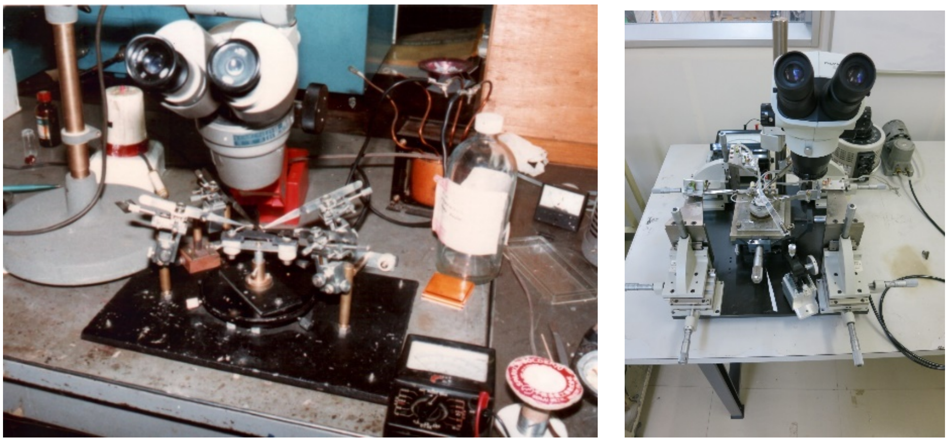
Electron beam evaporor (exhibited)

Parylene (Polyparaxylylene) deposition

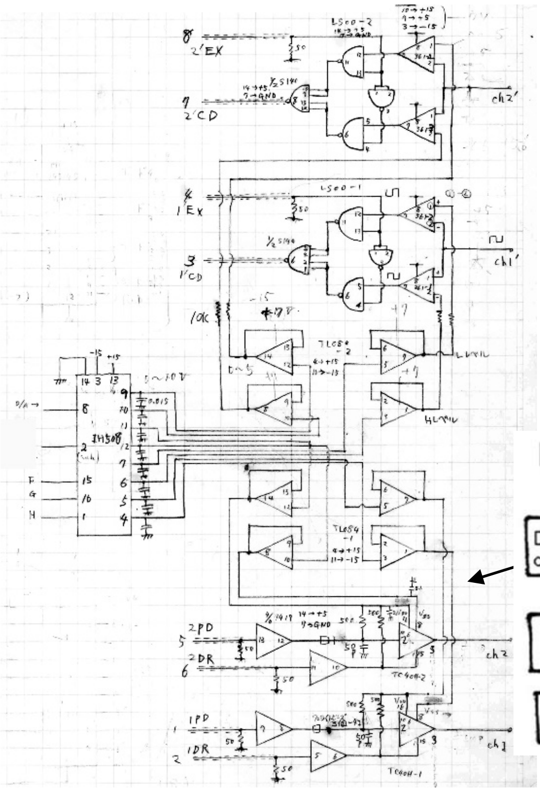
6 Assembly (dicing, wire bonding, soldering) and test

Dicing machine (chip separation from wafer)

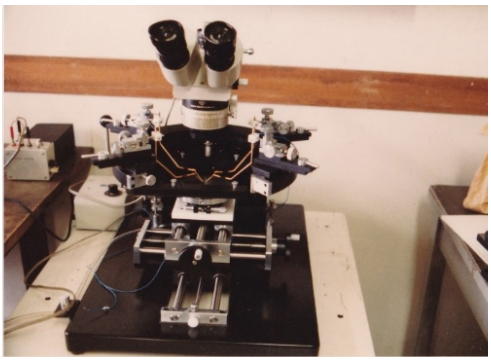
Ultrasonic wire bonder (exhibited)



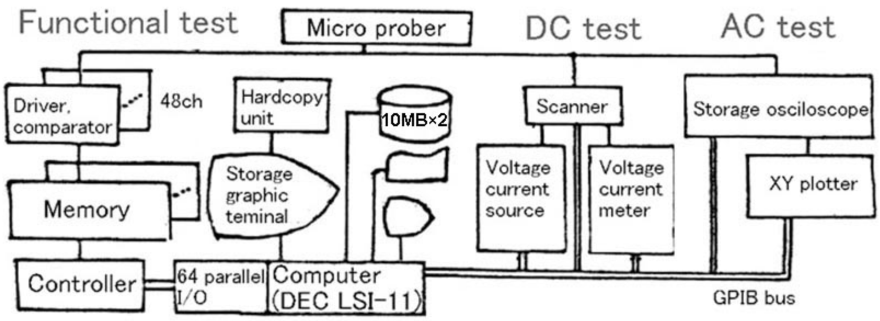
Micro soldering machine using cream solder (right exhibited)



Pin electronics for IC tester (2ch)



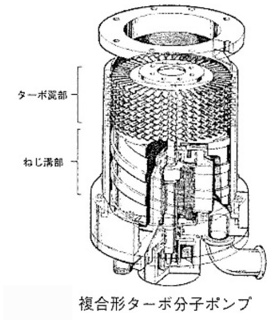
Microprober for testing



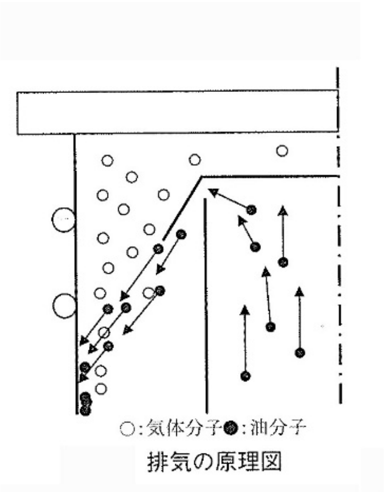
IC test system

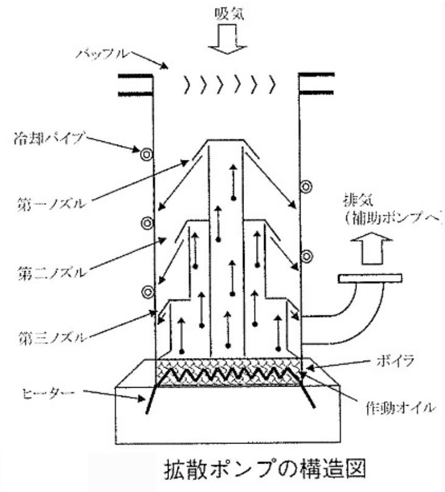
7 Vacuum pump (rotary pump, turbo molecular pump, diffusion pump, ion pump, cryopump)

Rotary roughing pump

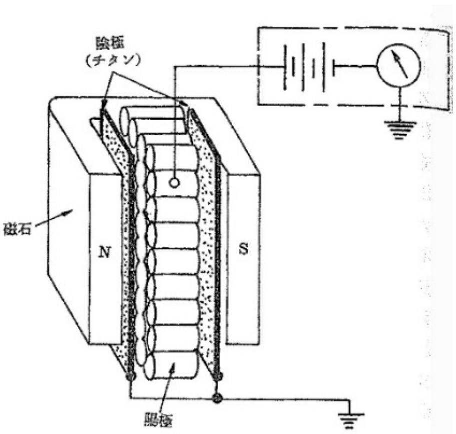


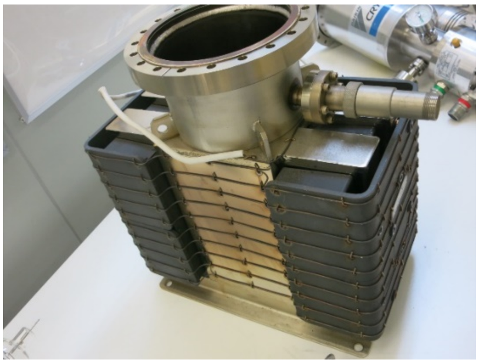
Turbo molecular pump



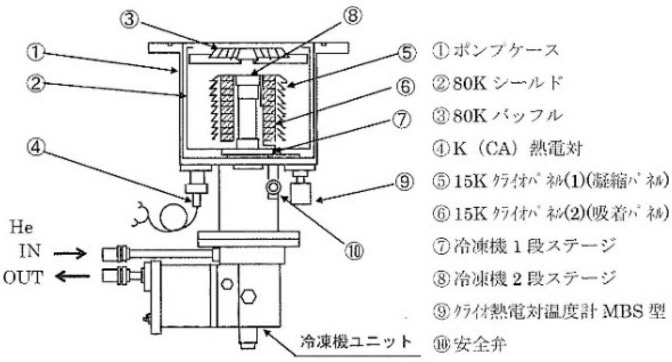


Oil diffusion pump (principle) and photograph of which K. Kumano made



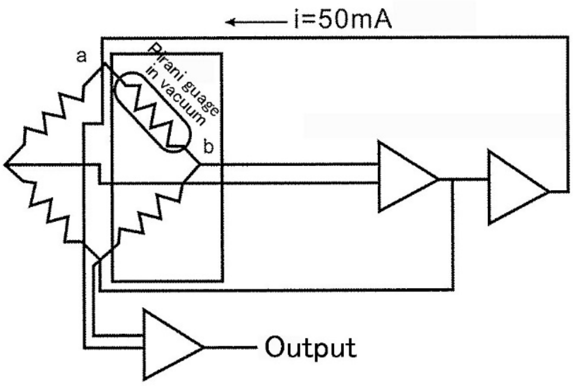


Ion pump (principle and photograph)

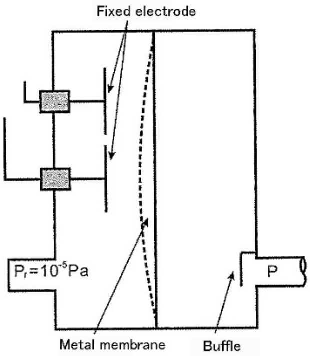


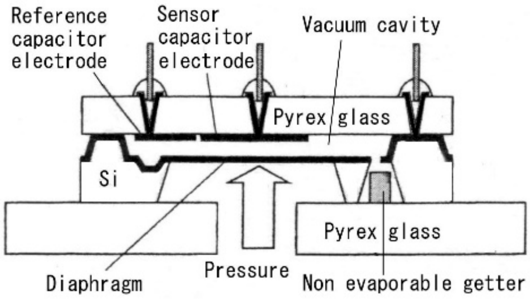
Cryopump (principle and photograph)

8 Vacuum gauges and quadrupole mass spectrometer



Pirani gauge (exhibited)





Diaphragm vacuum gauge (left exhibited)

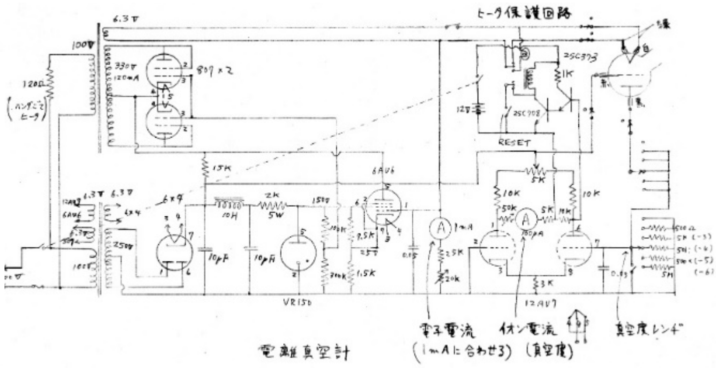
Thermal electron emission from heater

↓

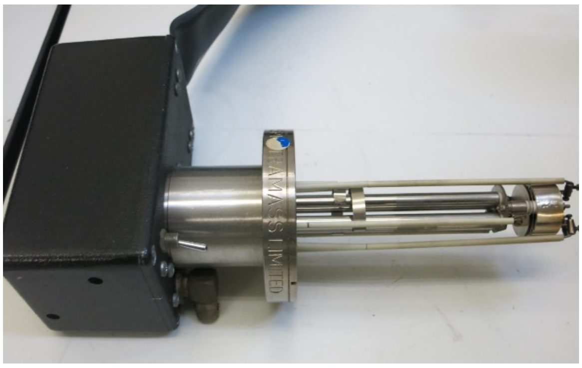
Molecules are ionized by electron

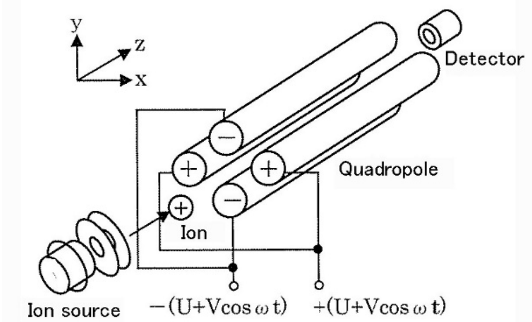
↓

Ion current is detected by anode



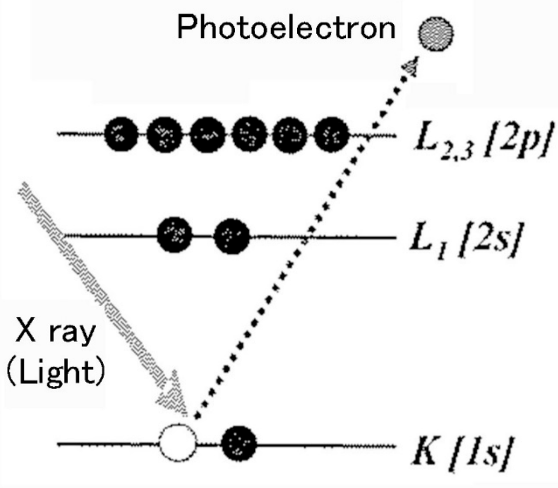
Ionization vacuum gauge (exhibited) and circuit



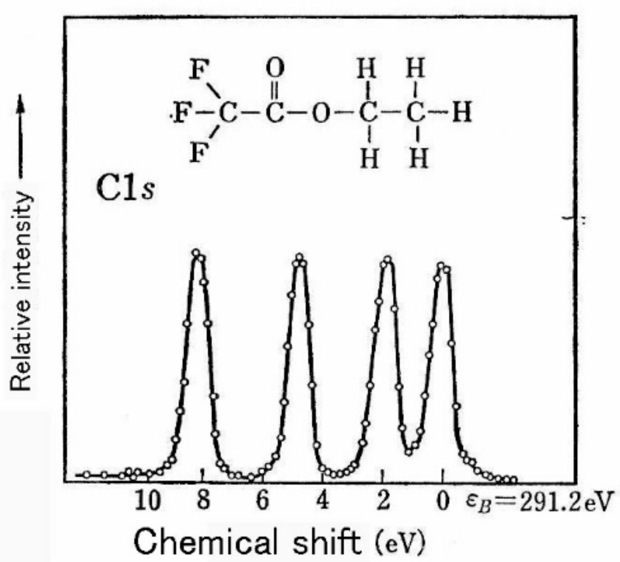


Quadrupole mass spectrometer (exhibited)

9 X ray photoelectron spectroscopy (XPS)

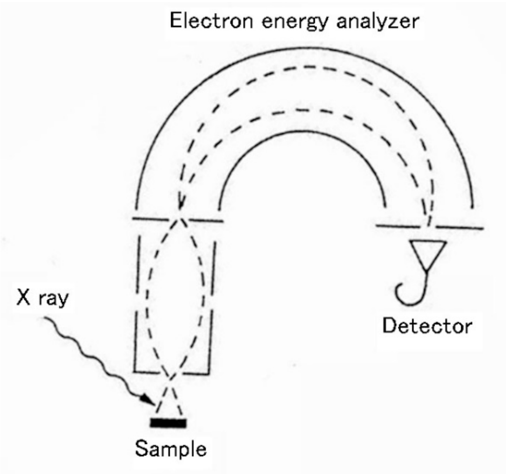


Emission of photoelectron

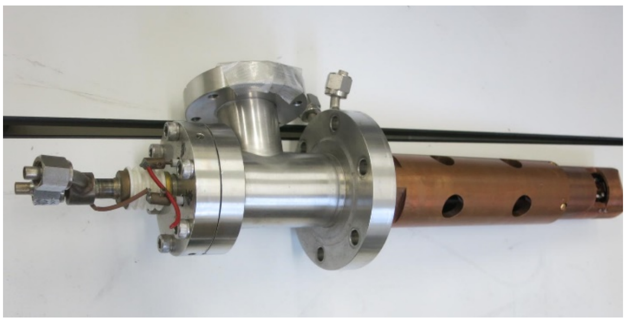


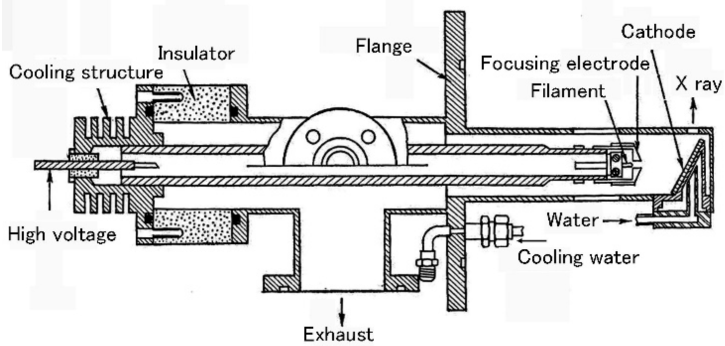
Principle

Example of X ray photoelectron spectroscopy (C1s spectrum of trichloroacetic acid) (K.Siegbahn : J. Electr. Spectry, 5, 3 (1974))



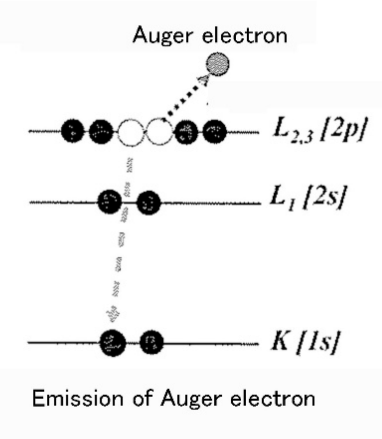
X ray photoelectron spectroscopy using hemispherical electron energy analyzer (exhibited)

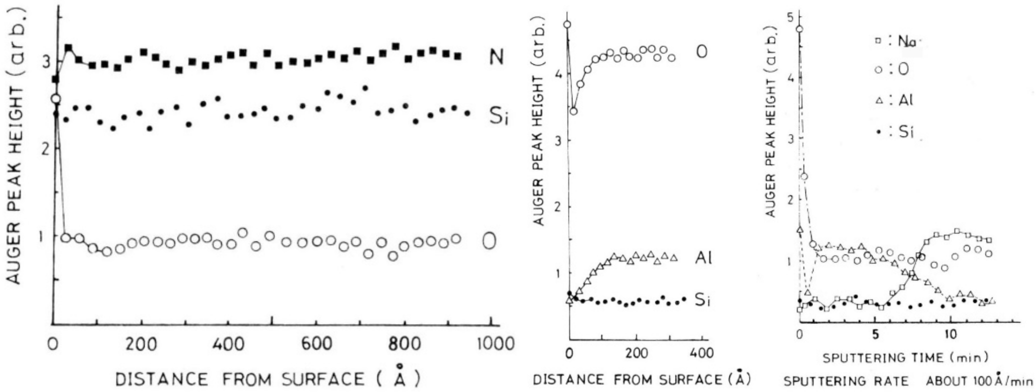




Xray source (exhibited) and its structure

10 Auger electron spectroscopy (AES)

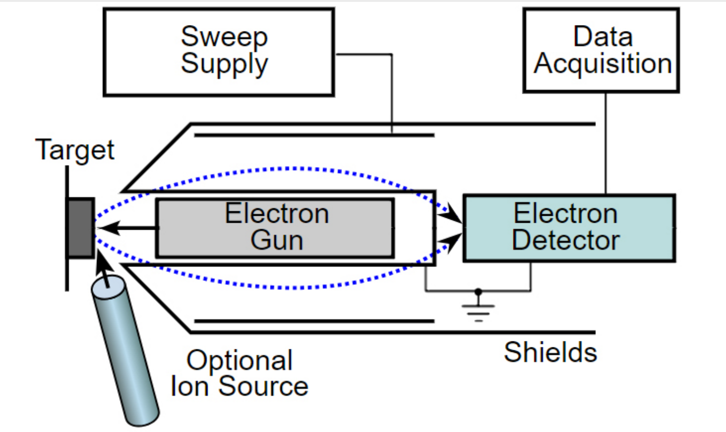




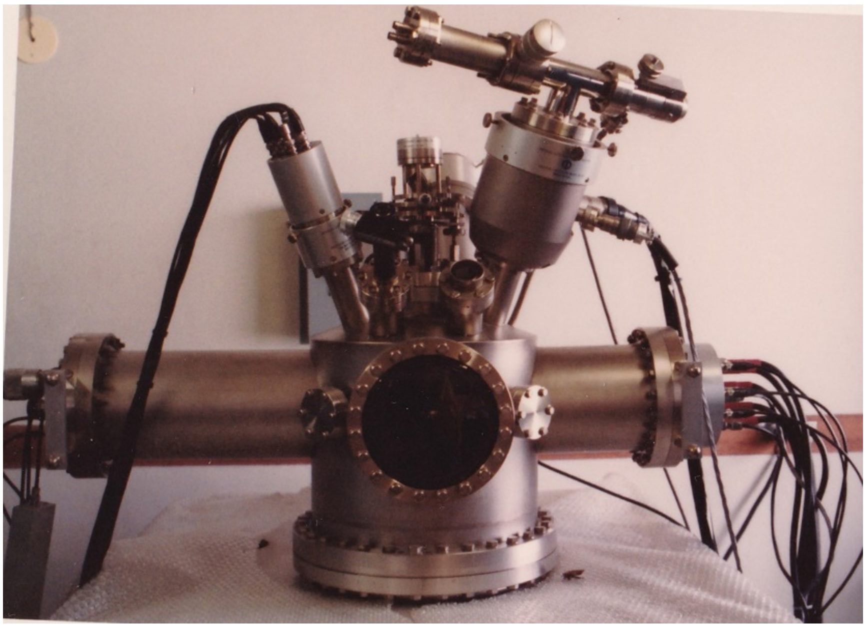
pH Si_3N_4 pNa Al_2O_3 pK Na doped Al_2O_3

Principle

Examples of AES (Semiconductor ion sensor (ISFET) surface)

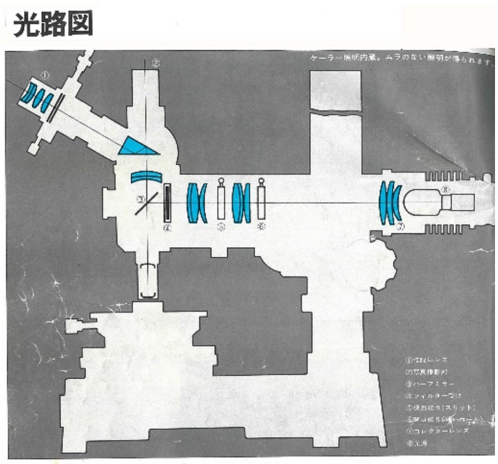


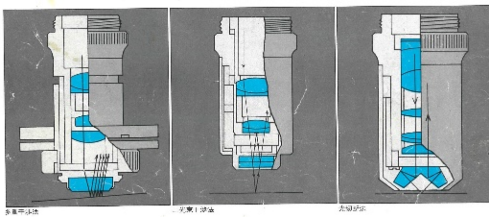
Cylindrical Mirror **Analyzer** (CMA) for AES (exhibited)



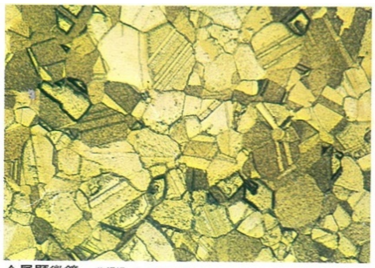
XPS (left) and AES (right) using the cylindrical Mirror **Analyzer** (CMA)

11 Optical microscope for measurement

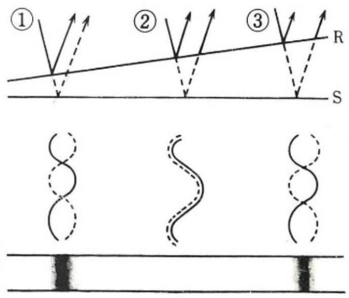




Multiple interference | Two beam interference | Light section method

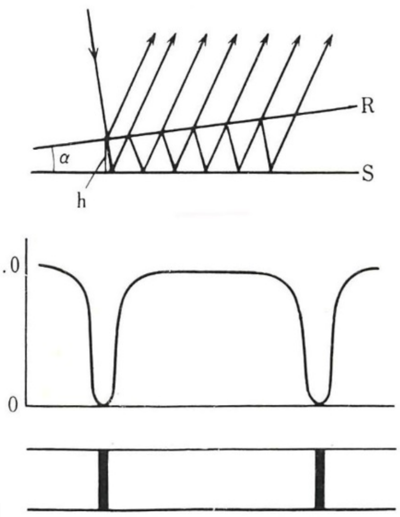


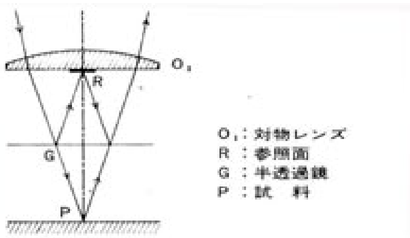
金属顕微鏡 黄銅板 M 10X CB165
※干渉フィルターには2種類あり、半値幅の狭いものはNB、広いものがWBです。

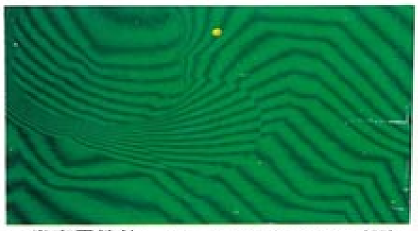


Principle of optical interference

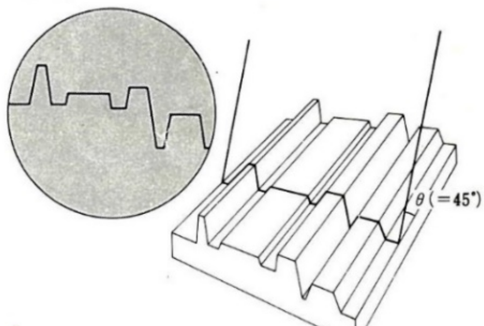
Surface finish microscope (Nikkon), Optical microscope, Optical interference



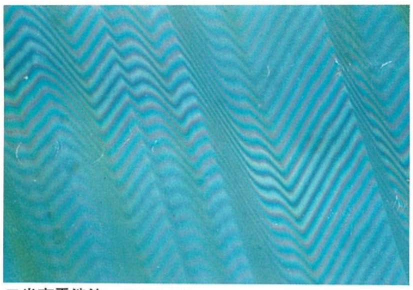




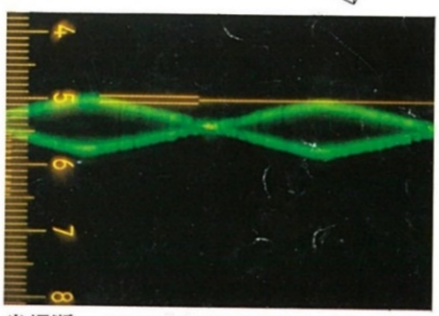
二光束干渉法 結晶 DI 10X 干渉フィルター(CB)



多重干渉法 結晶 MI 10X 干渉フィルター(NB)※



二光束干渉法 結晶 DI 20X

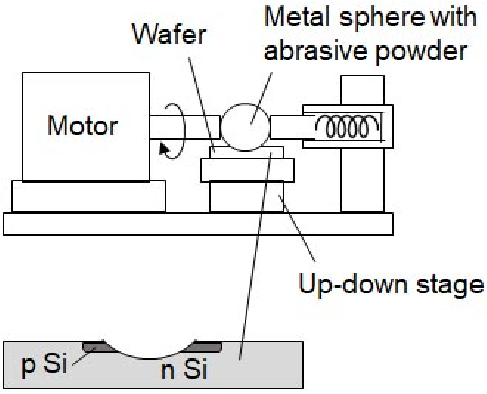


光切断 アラサ標準片 PS 10X 干渉フィルター(WB)

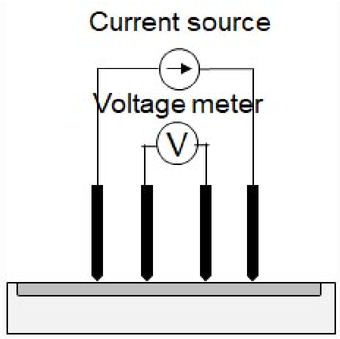
Multiple interference

Two beam interference

Light section method

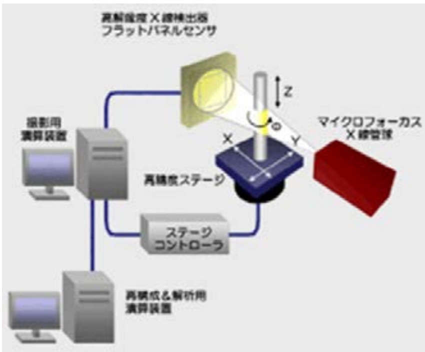


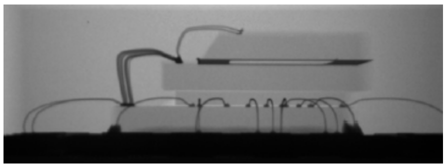
p Si is colored to measure depth after polishing in round shape by spherical drill



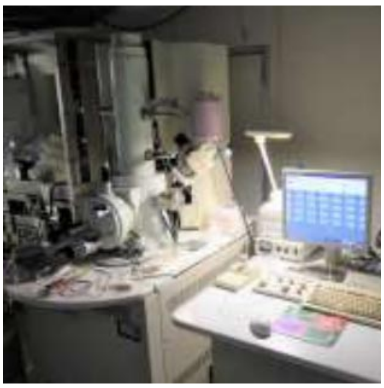
Measurement of sheet resistance by 4 probes

Atomic force microscope (AFM) (Park Systems NX-20)





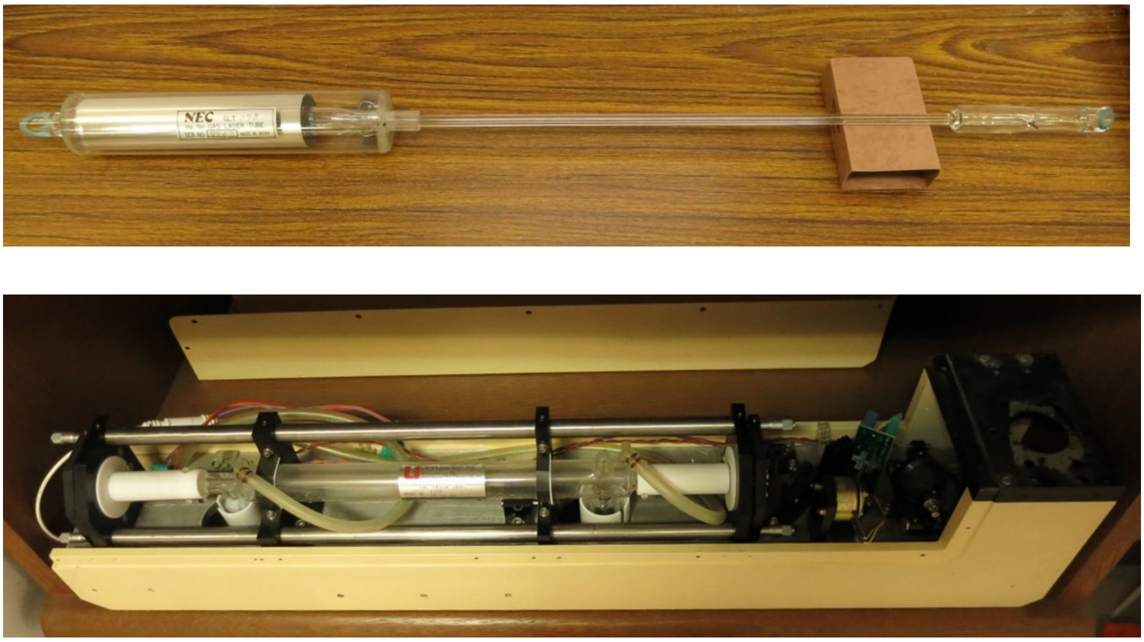
Micro X ray CT (used in clean room 1F) and cross-sectional image of 3D accelerometer



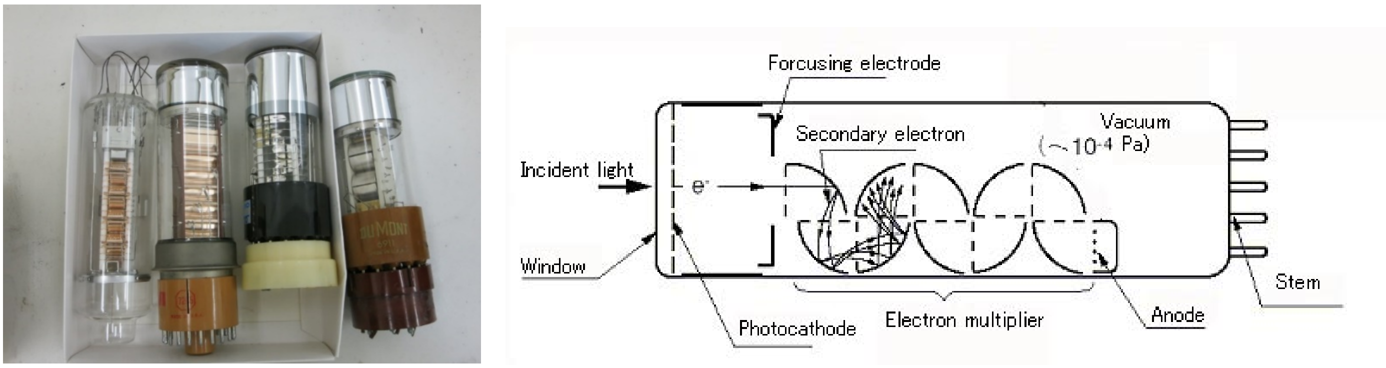
Scanning electron microscope (SEM)

X ray diffraction

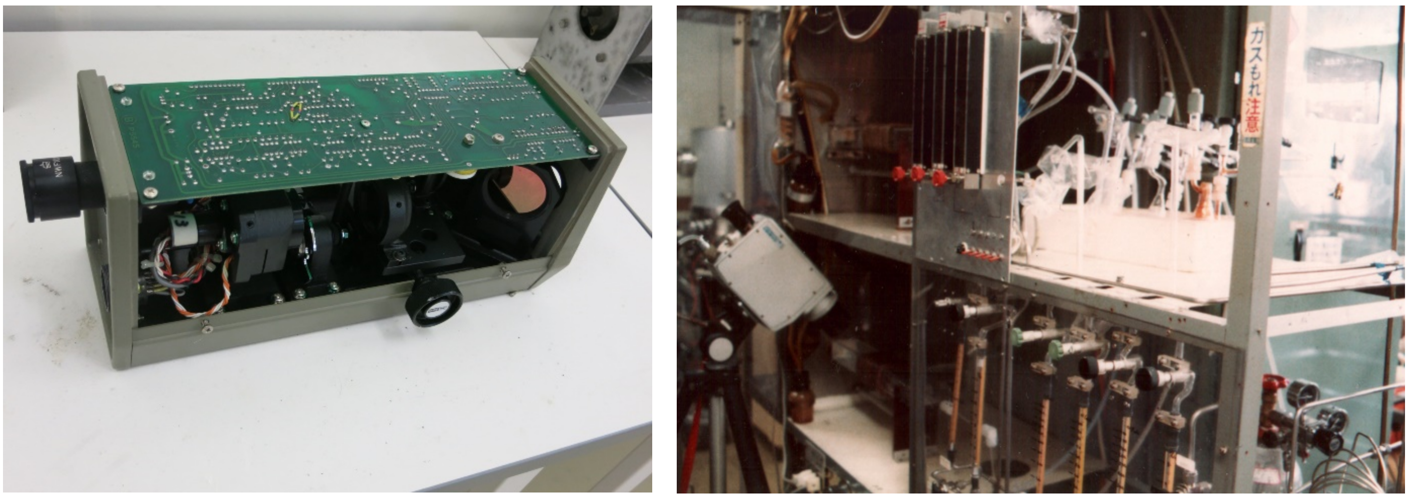
Gas laser, photomultiplier and radiation thermometer



Gas laser (laser tube (top), CO_2 laser (bottom)) (exhibited)



Photomultiplier



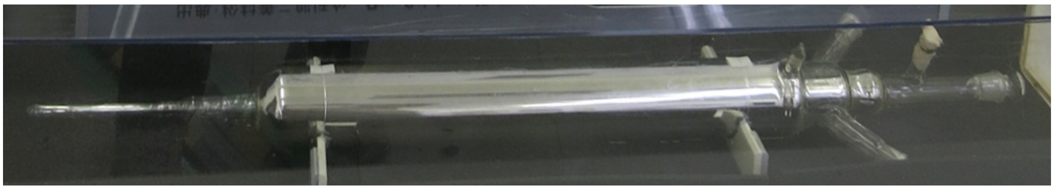
(Infrared) radiation thermometer and its application

14 A liq.^{4}He / liq.N_2 cryostat Dewer by double-duplex glass tubing (since 1973)

History of the development of lab-use glass equipment in Tohoku University can be going back in the same year as of the campus start. Together with the nurturing program of glass blow specialist and thanks in the collaboration with researchers, a lot of unique glass apparatus was made in the campus.

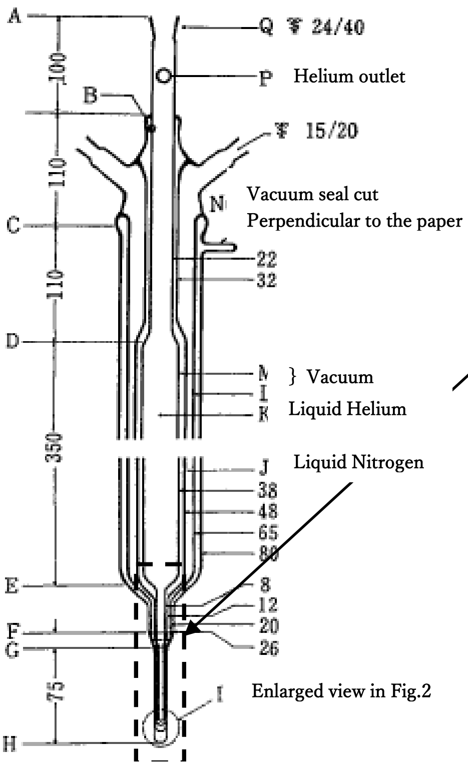
A liq.^{4}He / liq. N_2 cryostat, integrated as a single Dewer, was developed at Chemical Research Institute of Non-Aqueous Solutions, Tohoku University (later Institute of Multidisciplinary Research for Advanced Materials, Tohoku University) and tailored to specific research needs. Key to realize the cryostat Dewer lies in knowhow about Quartz/ Pylex glass blow joint tubing thinned to about 0.6mm thick. Multi-stage Quartz / Pyrex glass joint enabled the production of various type of glass cryostats, which were applied to low-temperature experiments such as infrared and UV-visible absorption spectroscopy, ESR spectroscopy, and AC magnetic susceptibility measurements.

The helium Dewar on display was crafted around 1984 by Zenjiro Matsumura for X-band ESR. It consists of four Quartz / Pyrex blown joint glass tubes, located in the reduced diameter region of the cylindrical body. There innermost quartz tube, served as liq. ^{4}He reservoir in the X-band cavity, has a small 5 mm diameter, which reduce helium consumption and assures a long measurements time.

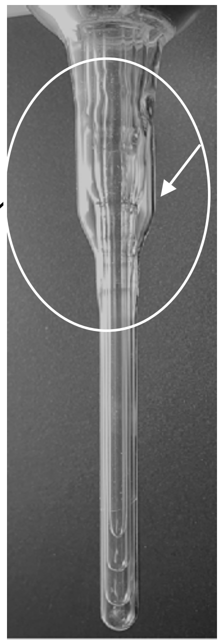


Double-duplex glass tube Helium cryostat Dewar Designed for long time measurement with minimal liquid Helium consumption

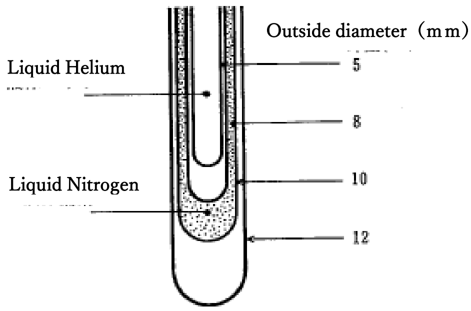
cons



Insert-Type Liquid Helium Cryostat. All dimensions are in mm; glass tube diameters refer to outer dimensions."



Each quartz/Pyrex glass joint sections are set by glass blow with vertical offset. Both the cavity quartz wall and vacuum gap are ~0.5 mm thick, ensuring a compact structure.



Quartz quadruple tube insertion section

The quartz tube is polished to thin, then the glass is joined.

Ref.; Matsumura et al, Rev. Sci. Inst., 45, 596 (1976)