VASSCAA-4/第49回真空に関する連合講演会　講演スライド

High-Speed Pumping to UHV

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Background

Development of a high-speed pumping system for UHV yields to us

- Reduction of cost and waiting time for aiming experiment and production
- Reduction of power consumption
- Reduction of CO_2 emission which seriously influences global warming

It is well known that

- High-speed pumping is limited by water desorption from chamber surface
- The reduction of roughness of a vacuum surface is able to reduce outgassing from the surface

Main source of water vapor absorbed on chamber surface

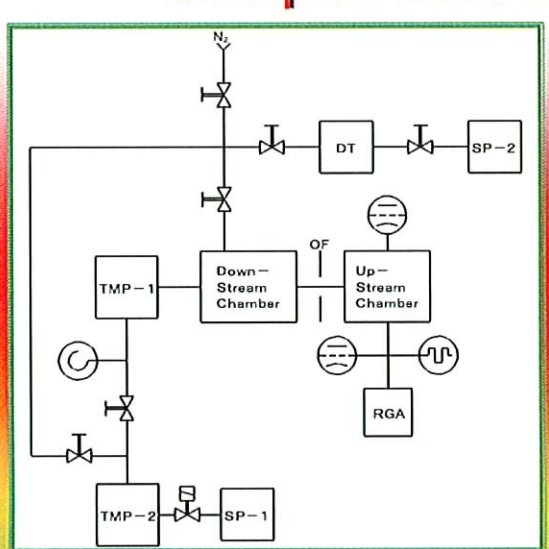
- Atmosphere
- N_2 of purge gas

Objective

In this work, we aim quick pumping down to UHV without baking of system

- control of water vapor in a N_2 gas purge line
- surface treatment of chambers
- measurement of outgassing rate and residual gas analysis

Setup of UHV System



DT : Dewpoint transducer
SP : Dry scroll pump
RGA : Residual gas analyzer
OF: Orifice

Experimental Procedure

Pumping Process

- Filled with nitrogen gas (4N) with 1atm at 1 hour
- The all pumps were suited on at same time

Measurement of Outgassing Rate

- Orifice: 5.2 x 10^{-3} m ^{3} s^{-1}, 297 K
- Introduced gas: N_2 or Air (Pressure: N_2 equivalent)

Experimental Procedure

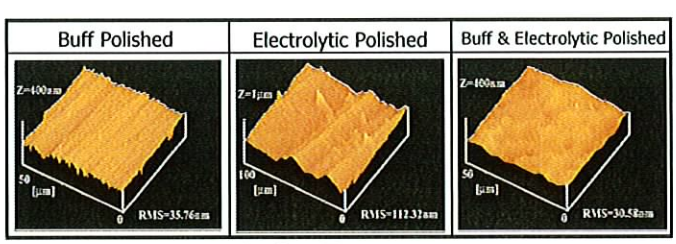
Surface roughness of the non-treated stainless steel

RMS=7.1μm

Treated with buff and electrolytic polished

Improved

RMS=30.58 nm



Surface Treatments

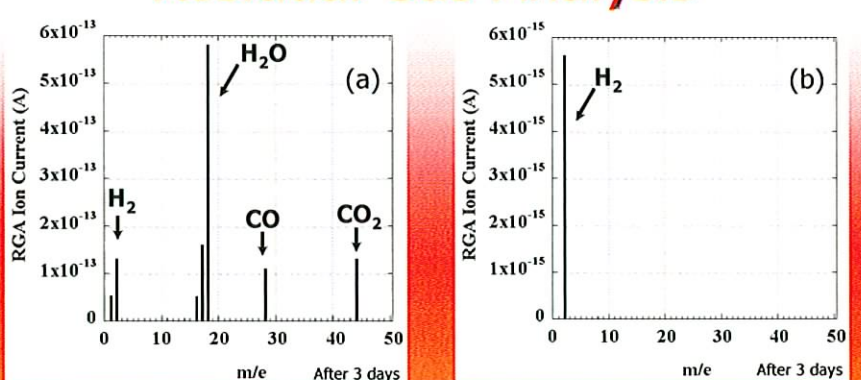
Water Vapor Concentration of Purge Gas

Purge gas	Purge Line	Water Concentration (vol. ppm)
Nitrogen	Stainless Steel Tube	0.065
Nitrogen		2.6
Nitrogen		12
Nitrogen	Polyurethane tube	160
Air	Stainless Steel Tube	12000

Water vapor concentration of purge gas is

- significantly influenced by product material of the gas purge line
- considerably reduced with baking of the purge line and N_2 gas flow rate in the line

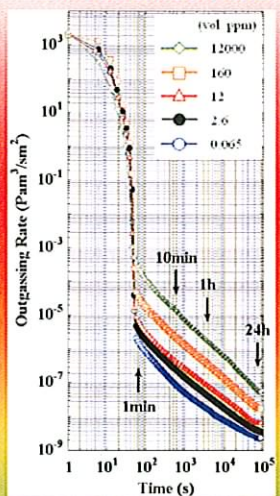
Residual Gas Analysis



	(a)	(b)
Water Concentration	12000ppm in Air	0.065ppm in N_2 gas
Residual Gas Species	Water vapor	H_2 gas

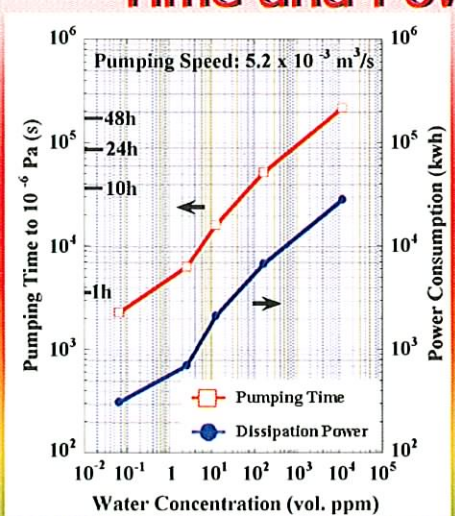
This quality of residual gas is equivalent to the quality in a baked UHV system

Outgassing Rate Influence of Water Concentration



- Outgassing rates remarkably decreased with decreased of water vapor concentration of N_2 purge gas
- Water vapor from the purge gas had bad influence on the pumping time
- Outgassing rate of 3×10^{-9} $Pam^3s^{-1}m^{-2}$ was obtained without baking

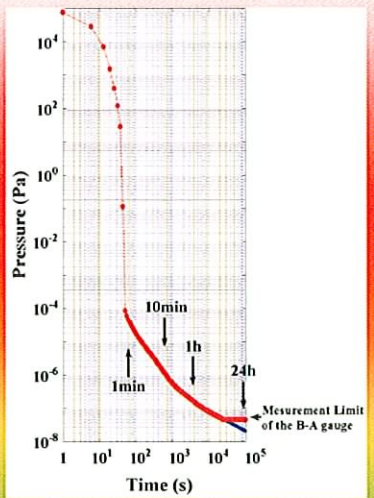
Influence of Water Vapor on Pumping Time and Power Consumption



Water vapor in the purge gas	Reduction ratio of	
	Electrolytic Power	Pumping Time
0.065	1/100	1/90
2.6	1/35	1/40
12	1/15	1/15
160	1/20	1/4
12000	1	1

The pumping time to reach the pressure of 1×10^{-6} Pa was also able to be shortened with two orders of the magnitude

Quick Pumping Without Under Control of Water Vapor



Pumping down without orifice after exposure N_2 gas with water vapor of 0.11vol. ppm

A pressure of $3x10^{-8}$ Pa was obtained after 24 hours

Conclusion

- We carried out control of water vapor in a N_2 gas purge line in addition to surface treatments of chambers.
- It was found that the main residual gas in the chamber without baking was H_2 after pumping down with the low concentration of water vapor. This quality of residual gas is equivalent to the quality in a baked UHV system.
- The introduction of well controlled N_2 gas to the vacuum system which was not baked out has proved a pressure of $3x10^{-8}$ Pa for 24 hours in the chamber without orifice. The pumping time to reach the pressure of $1x10^{-6}$ Pa was also able to be shortened with two orders of the magnitude.
- High-speed pumping demonstrated in this study should considerably contribute to reduce waiting time before vacuum work and electrical power consumption, namely, CO_2 emission which seriously influences global warming