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Adsorption of ammonia on metal and polymer surfaces

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European Association of National Metrology Institutes

EMRP
European Metrology Research Programme
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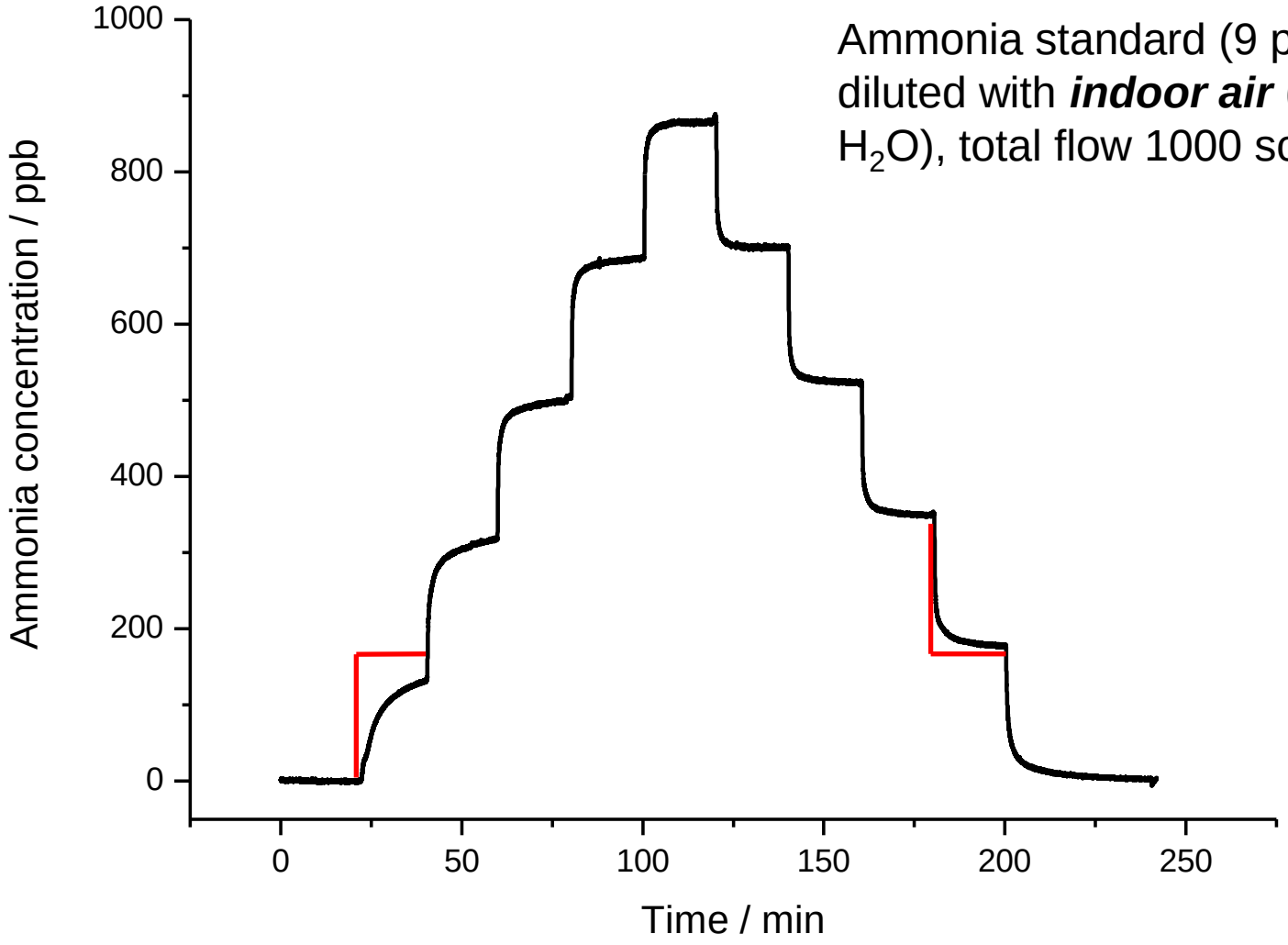

Ammonia standard (9 ppm NH_3 in N_2) diluted with ***indoor air*** (10000 ppm H_2O), total flow 1000 sccm

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Variables

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Test tube coating: stainless steel 316L, electro-polished SS 316L, SilcoNert 1000, SilcoNert 2000, Dursan, PFA, FEP, PTFE, PELD, PVDF

NH_3 concentration: 10 ppb – 9 ppm (400 or 9000 ppb)

Flow rate: 0 – 2000 sccm (200 or 1000 sccm)

Temperature: 295 – 333 K (295 K)

Water content: 0 – 1 % (25 ppm)

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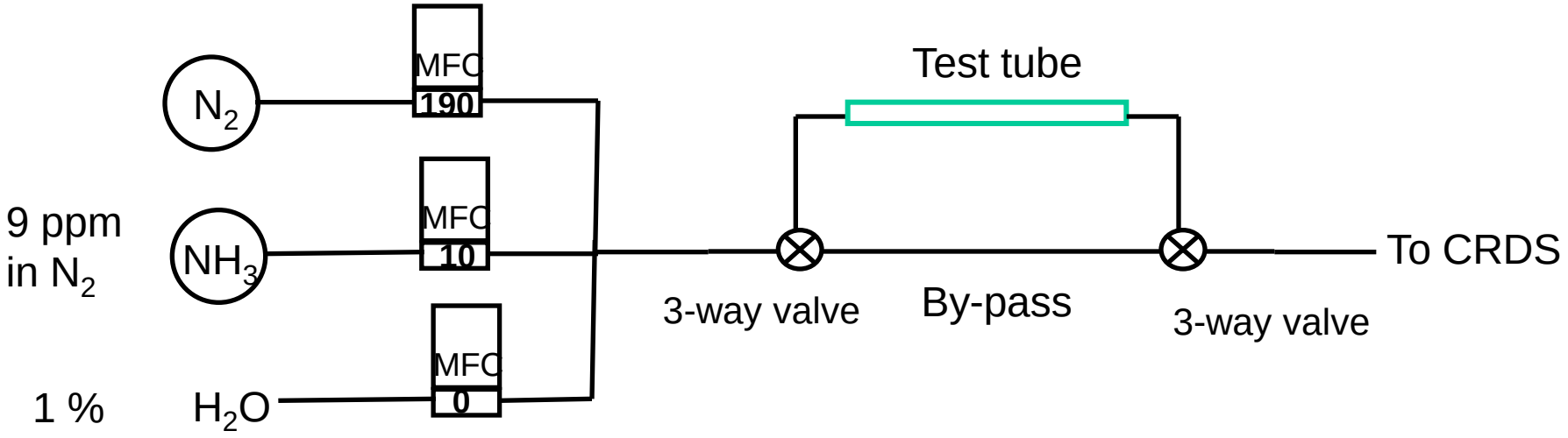
Gas generation setup



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Study protocol

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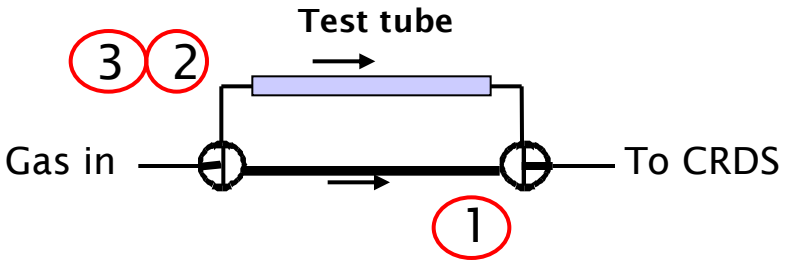
A) Test tube is flushed with indoor air (≥1 h) and pure N_2 (≥0.5 h)

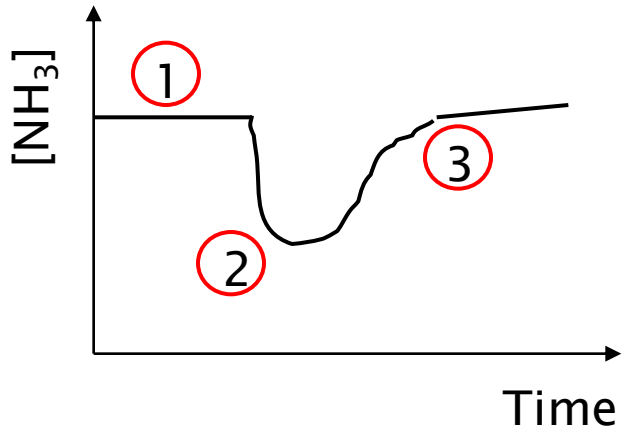
B) Vacuum line and ring-down cavity (except test tube) are exposed to NH_3 (in N_2)

C) Concentration of ammonia is measured after ~1 h

D) Actual real-time adsorption measurement at 6548.79 cm^{-1} in 3 phases:

1) Ammonia gas flow via by-pass line
2) Ammonia flow switched to go via test tube
3) Slow recovery of ammonia signal





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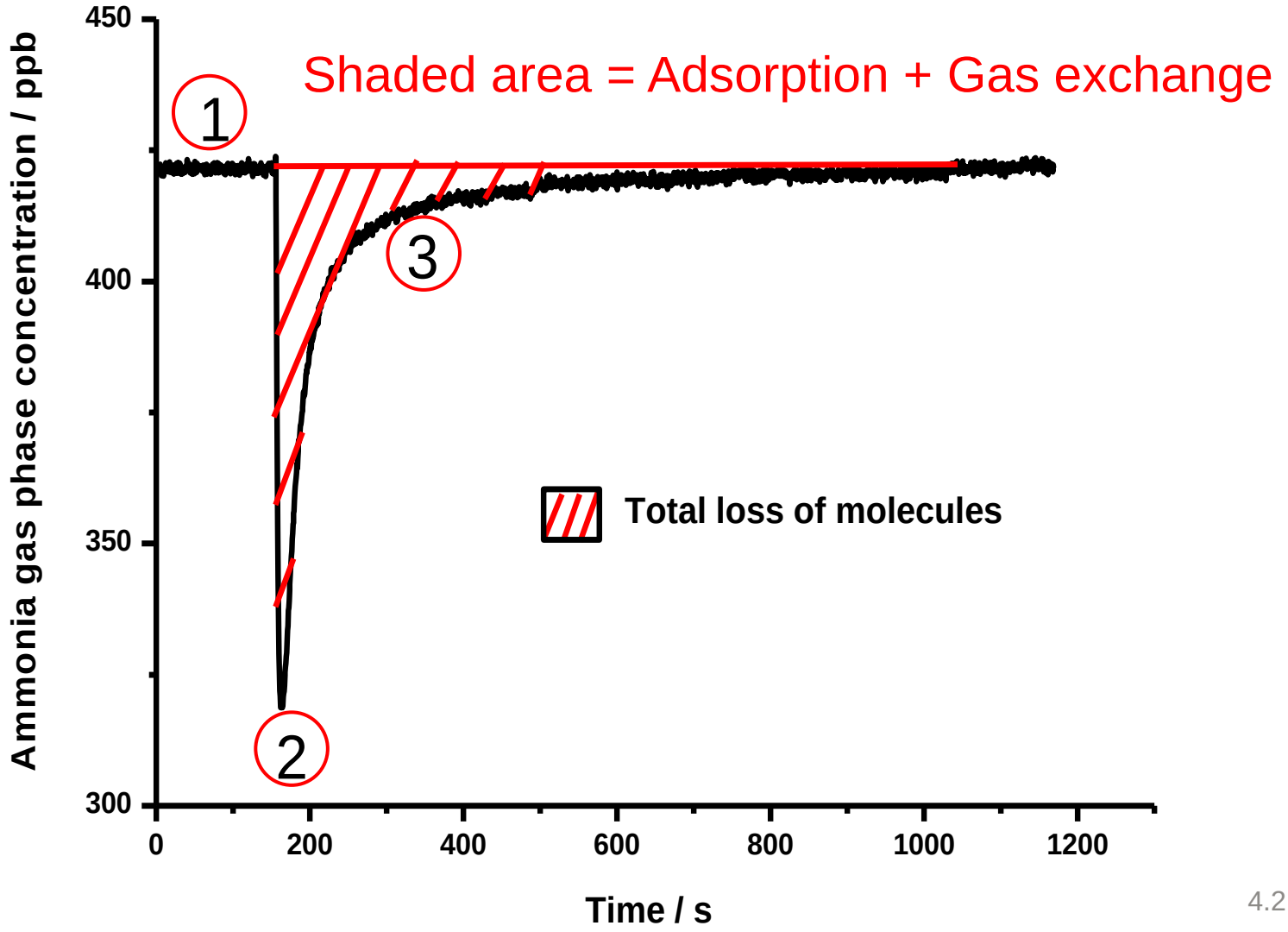
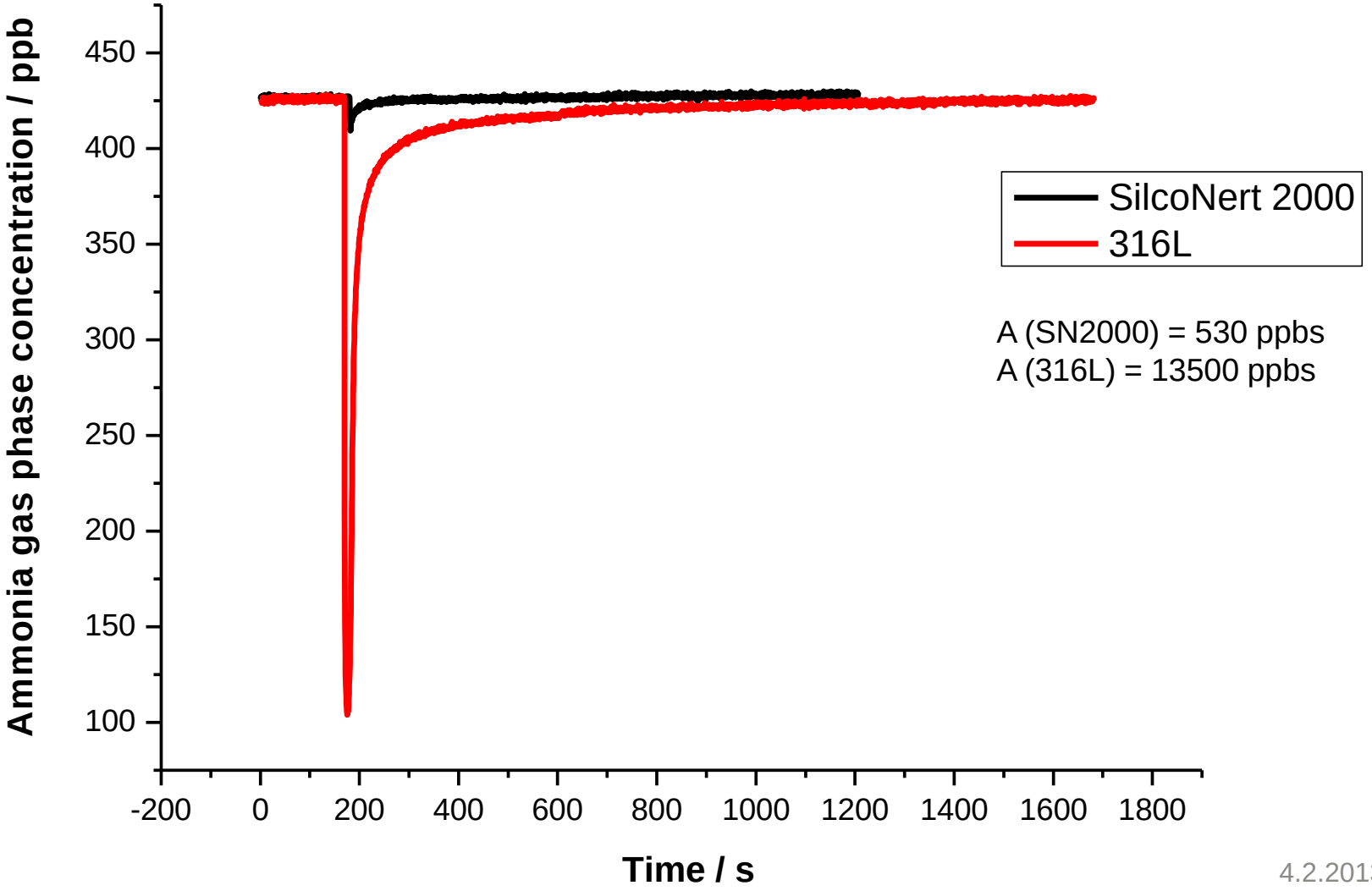
Dursan, 420 ppb




Ammonia gas phase concentration / ppb
450
400
350
300
250
200
150
100
-200
0
200
400
600
800
1000
1200
1400
1600
1800
Time / s
SilcoNert 2000
316L
A (SN2000) = 530 ppbs
A (316L) = 13500 ppbs

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Adsorption on metal / coated surfaces

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Metal / coating	Adsorption* (10^{12}molecules/cm^2)	St. deviation (10^{12}molecules/cm^2)
SilcoNert 2000	5.7	0.6
SilcoNert 1000	14.6	0.9
EP SS316L	72	11
Dursan	101	5
SS316L	138	21

*Average of 3 measurements

NH_3 conc = 420 ppb, p (tube) = 176 mbar

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Adsorption on polymer surfaces

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Polymer	Adsorption* (10^{12}molecules/cm^2)	St. deviation (10^{12}molecules/cm^2)
PVDF	1.0	0.1
PELD	4.4	0.6
PTFE	7.5	1.9
FEP	8.6	0.3
PFA	13.9	1.0

*Average of 3 measurements

NH_3 conc = 8750 ppb, p (tube) = 119 mbar

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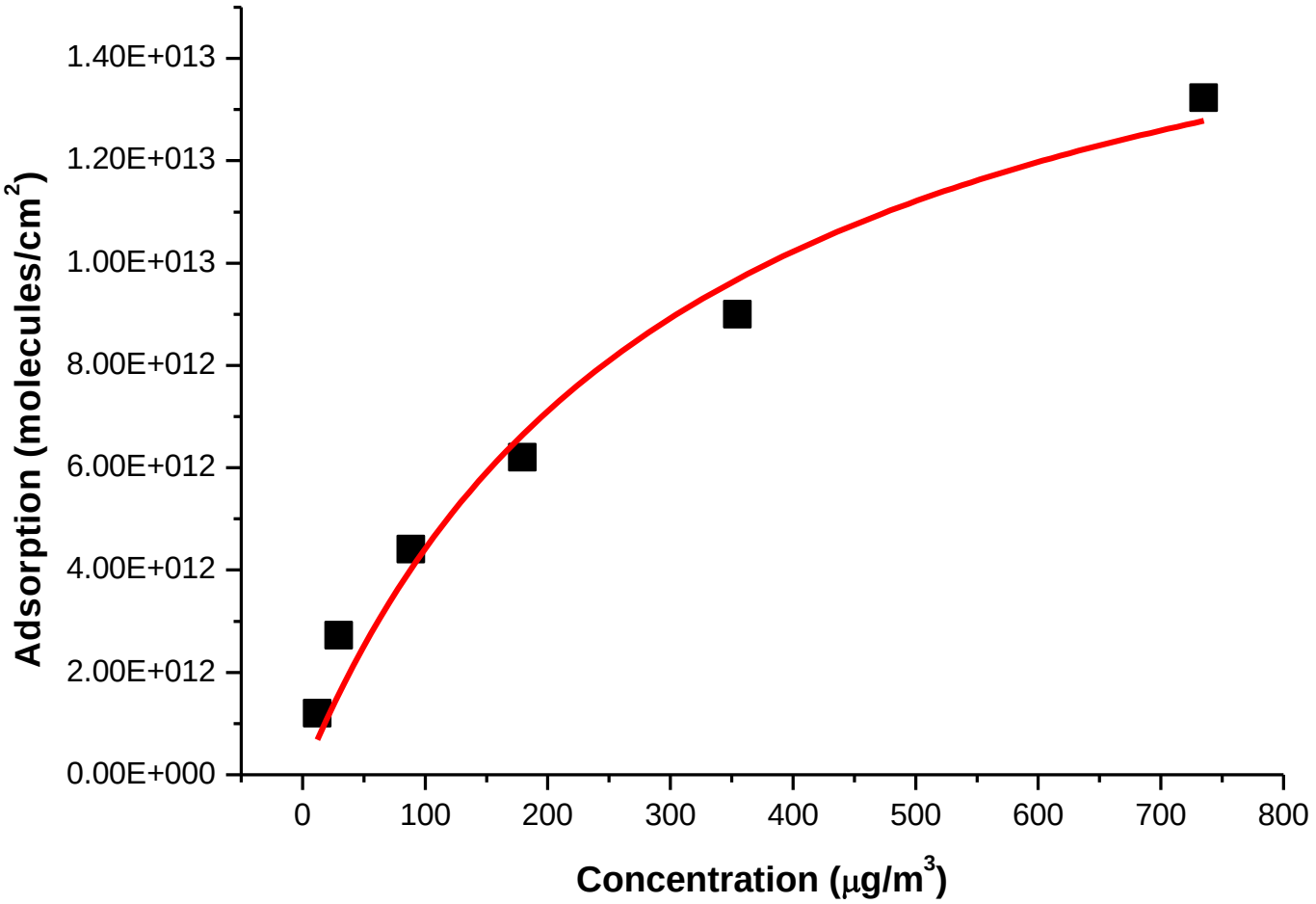
Langmuir isotherm



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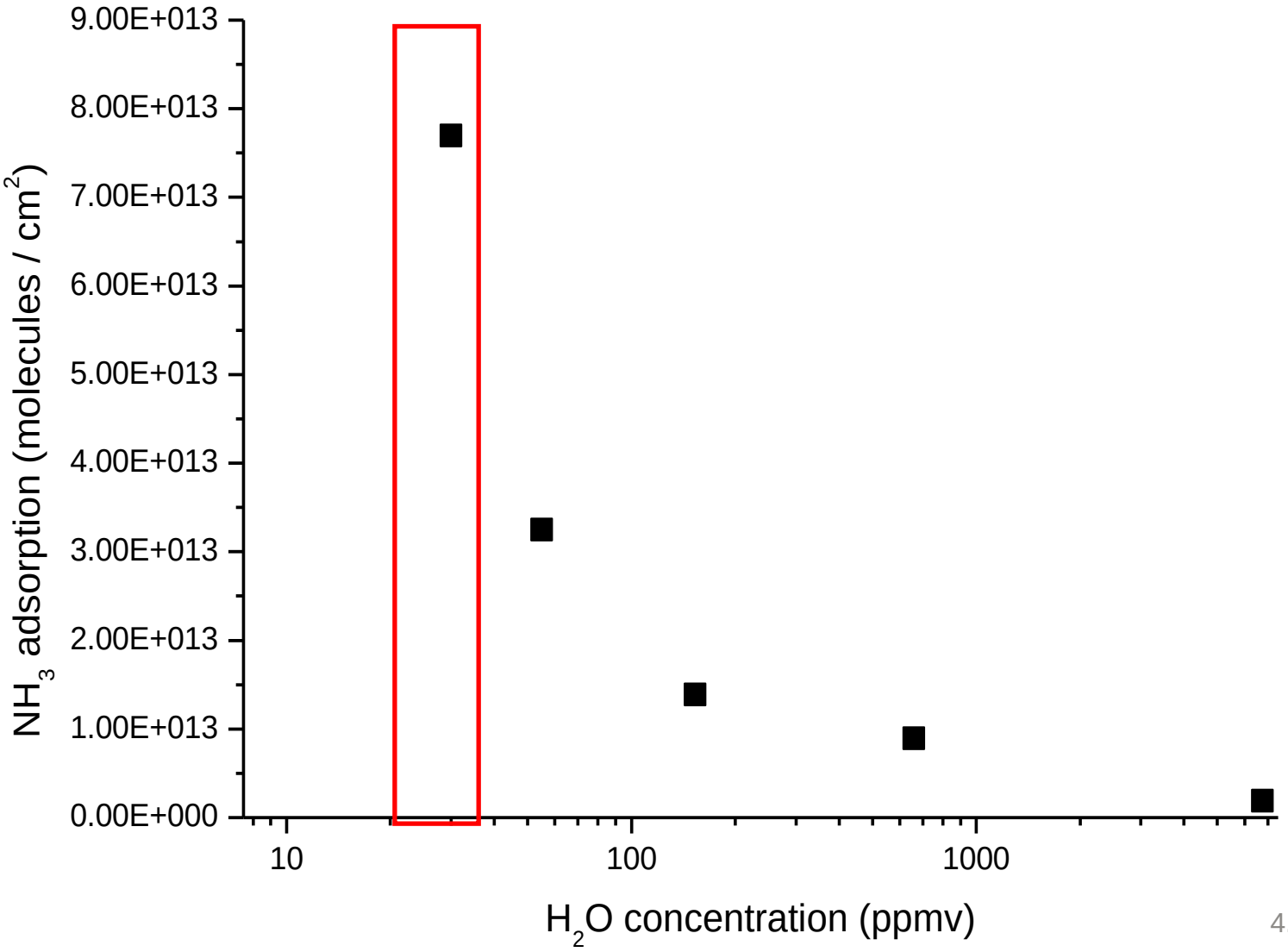
Effect of water

SS 316L



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Comparison to PTR-MS data*

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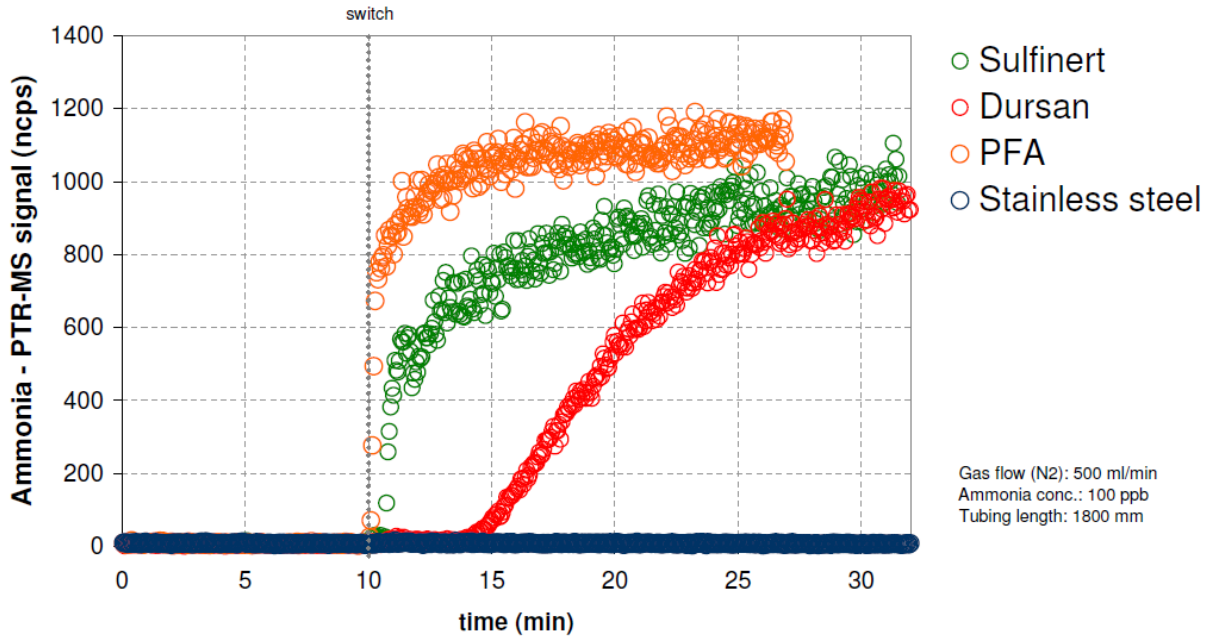
CRDS:	**PTR-MS:**
SS > Dursan >> SN2000 > PFA	SS >> Dursan >> SN2000 > PFA

Ammonia transport through different tubings



*SilcoTek Corporation, Sulfinert = SilcoNert 2000

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Acknowledgements

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VSL Dutch Metrology Institute

SilcoTek Driving Innovation

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