Implementing Total-Pressure Rise Method for Resist Outgas Measurement

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This method is under evaluation as a potentially low-cost test with fast turn-around for determining total molecules outgassing from a resist *(if resist outgas testing is needed)*.

The Pass/Fail limit for total molecules would need to be established from some other method, such as limited witness plate testing.

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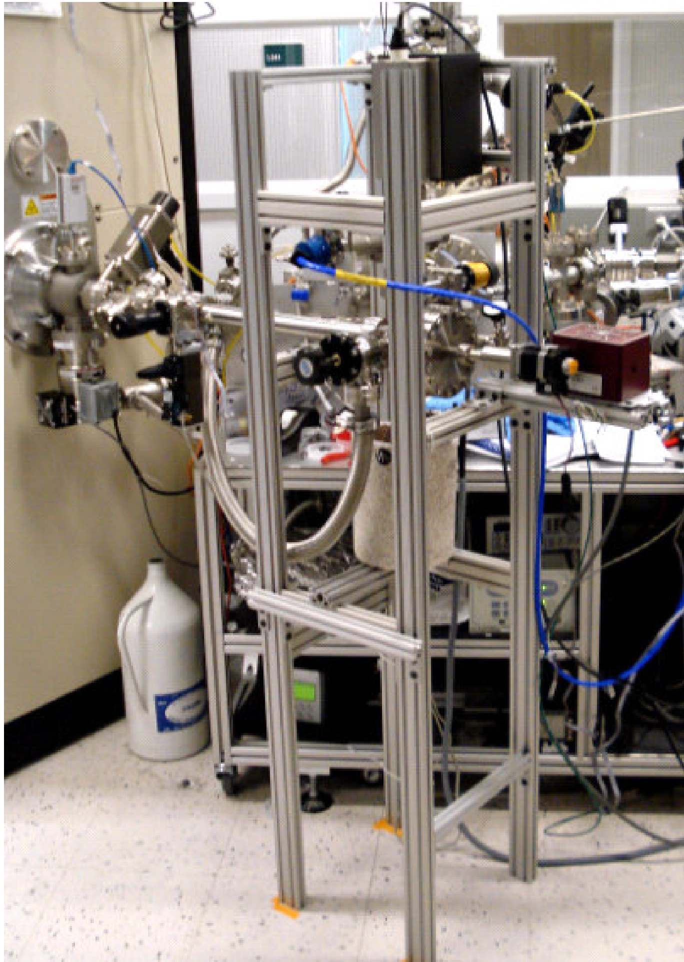
Introduction

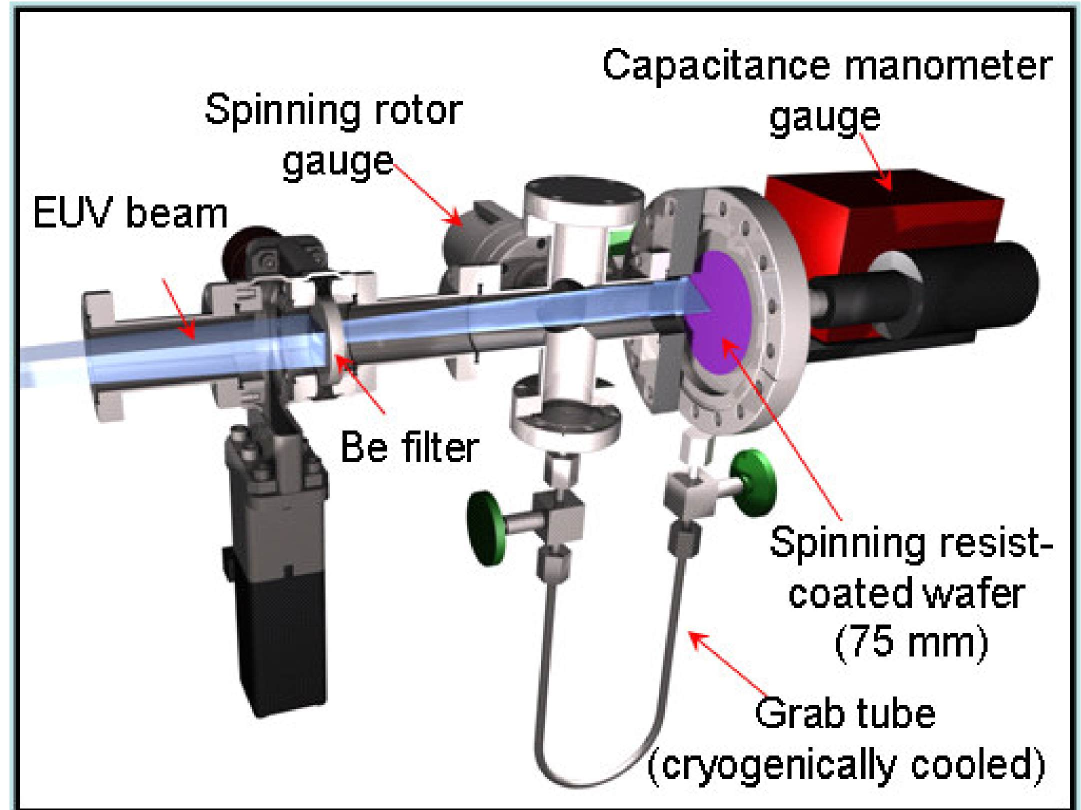
- Selete publication (1) at SPIE 2007 on pressure rise method
  - Used Ion Guage to measure total pressure rise.
- NIST recommends Spinning Rotor Guage (SRG) or Capacitance Displacement Gauge (CDG) as accurate, reproducible methods for measuring pressure rise. This work concentrated on the SRG:
  - Steel ball magnetically levitated and inductively driven.
  - Rate of slowing of rotational motion gives pressure.
  - NIST data (2) shows good agreement (few %) to National Standard over pressure range of 7.5E-5 Torr to 0.15 Torr.
- The purpose of this work is to investigate the implementation of total pressure rise testing and recommend methodology.

(1) J. Santillan, M. Toriumi, and T. Itani, "A Study of EUV Resist Outgassing Characteristics Using a Novel Outgas Analysis System", Proceedings SPIE, vol. 6519, pp 651944-1 – 651944-7, 2007.

(2) J. Setina and J.P. Looney, "Behavior of Commercial Spinning Rotor Gauges in the Transition Regime", *VACUUM*, vol. 44, #5-7, pp 577-580, 1993.

Portable Vacuum Test Chamber build by NIST





Chamber tested first at University of Albany with pulsed EUV light.
Will be installed on NIST synchrotron for further testing.

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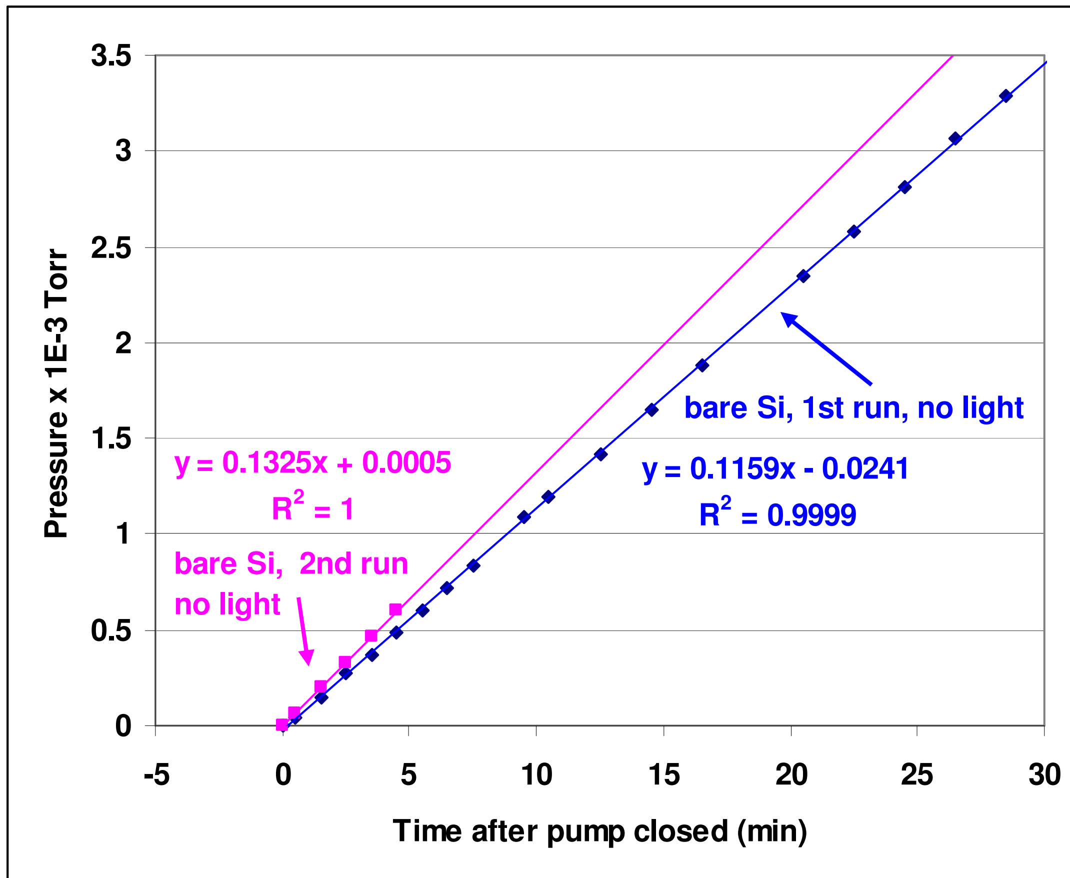
Experimental procedure

- Wafer hand loaded into small chamber, pumped down.
- When desired vacuum pressure reached, pumps closed off and background (no EUV light) chamber pressure rise measured (~ 5 minutes).
- Turn on EUV light and measure resist outgas rate (expose 3 inch wafer to ~2.5Eo), then turn off EUV light.
- Continue to monitor chamber background pressure rise from that point (~ 5 minutes)
- The pre and post illumination background rates are used to subtract chamber background outgassing from the total pressure rise measured with the light on.

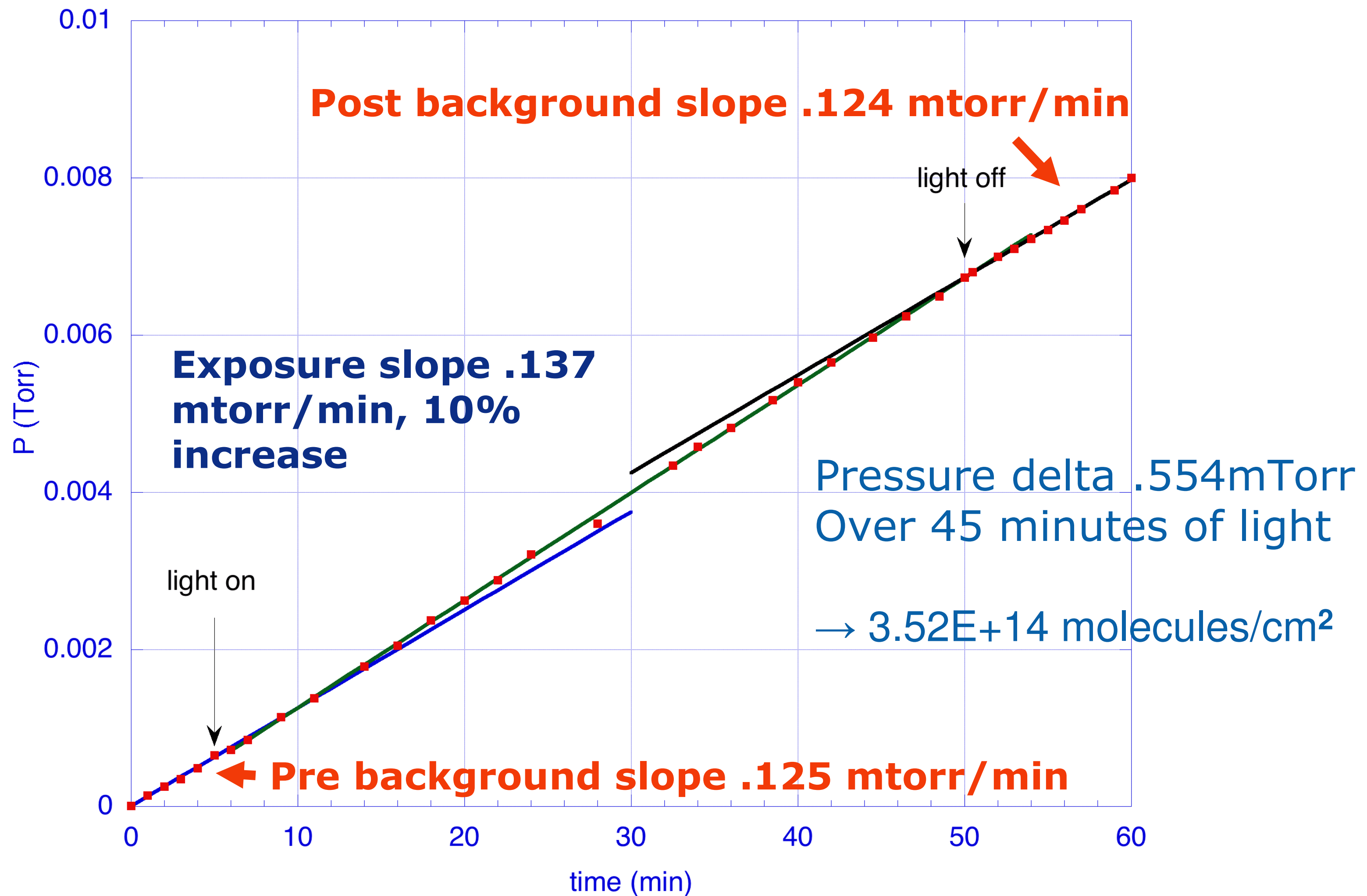
Background pressure rise, bare Si without light.



Background Pressure rise due to chamber outgassing can vary greatly from run to run, need specific background rate.

Measure background during run before and after light illumination.

Testing with Resist



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Testing with Resist

- Run 1 (1 hour pumping on wafer): 3.52E+14 molecules/cm^2
- Run 2 (1 hour pumping on wafer): 3.96E+14 molecules/cm^2

} 13%

- Run 3 (13 hours pumping on wafer): 1.72E+14 molecules/cm^2

➢ Current chamber design gives very low EUV power at wafer, taking 45 minutes to expose 3 inch wafer to 2.5Eo

➢ Background chamber pressure rise during this 45 minutes limits current sensitivity to ~ 1E+14 molecules/cm^2

➢ NIST plans to upgrade setup for higher power levels which will improve sensitivity.

➢ More data will be ready during SPIE in Feb'2008.