RGA Analysis of Plasma Cleaned Vacuum Systems

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Abstract

The goal of this project was to qualitatively evaluate the efficacy of using plasma cleaning to remove PDMS from vacuum systems. Silicon containing compounds are notorious for interfering with vacuum system techniques such as x-ray photoelectron spectroscopy (XPS), Auger Electron Spectroscopy (AES) and Secondary Ion Mass Spectrometry (SIMS). Finding a way to remotely and rapidly remove contaminants from a system saves time and money for analysts using vacuum analytical techniques.

RGA:

- An RGA is a mass spectrometer.
- An RGA is composed of an Electronics Control Unit (ECU) and a probe.
- RGAs are most often used to monitor the quality of vacuum and to identify contaminants.

Taken from SRS RGA website: www.thinksrs.com

The image to the left is an SRS® RGA. The experiments mentioned in this poster used the Transpector 2® RGA. However, the SRS® has a similar physical appearance.

Evactron® Plasma Cleaner:

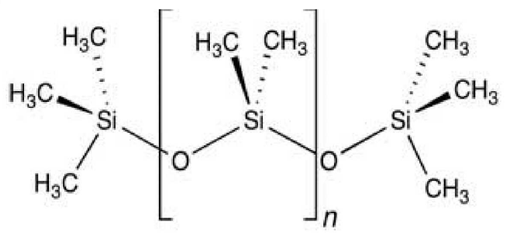
- The XEI Evactron® uses air plasma to rid surfaces of contaminants .
- The cleaner can be modified to use other inert gases such as Argon (Ar) and Nitrogen (N_2).

The image to the right is the Evactron® Plasma Cleaner by XEI Scientific used in these experiments.

Taken from Evactron® website: www.evactron.com

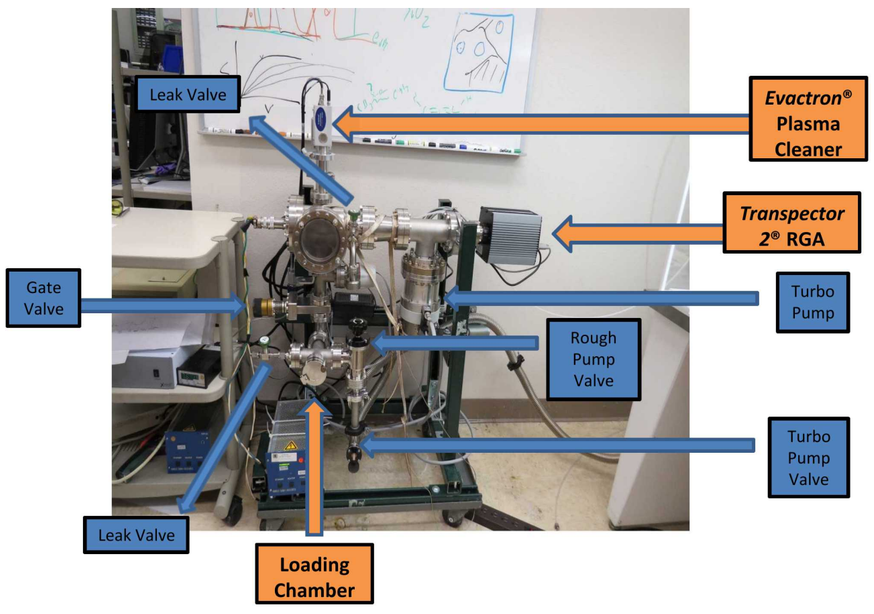
PDMS:

- A common Si-containing polymer that has already been researched heavily.
- Has an end chain mass of 73 amu and a short chain length mass of 147 amu that RGA identifies easily.



Taken from www.physicscentral.com.

The image to the left depicts PDMS with n chains. The end segment on the right is the 73 amu signal and the end segment plus one unit of PDMS accounts for the 147 amu signal.



Procedure:

- Run a control RGA scan without any sample (**Results: Figure 1a**).
- Placed PDMS in the chamber and heated sample while running RGA (**Results: Figure 1b**).
- Ran RGA at two higher temperature settings (**Results: Figure 1c and 1d**).
- Closed gate valve and ran RGA (**Results: Figure 1e**).
- Plasma cleaned the main chamber, then ran RGA (**Results: Figure 1f**).
- Opened the gate valve and ran RGA at two different heat settings (**Results: Figure 2a and 2b**).
- Plasma cleaned with sample still in loading chamber and ran RGA (**Results: Figure 2c**).
- Removed sample, plasma cleaned and ran RGA once more (**Results: Figure 2d**).

Results:

The data generated from the se experiments provide convincing qualitative results that showing that the Evactron® Plasma Cleaner removes PDMS effectively. The RGA spectra and partial pressure versus time plots below demonstrate how well the plasma cleaner removes contaminants from a vacuum system. The following data is organized into various experiments over two days.

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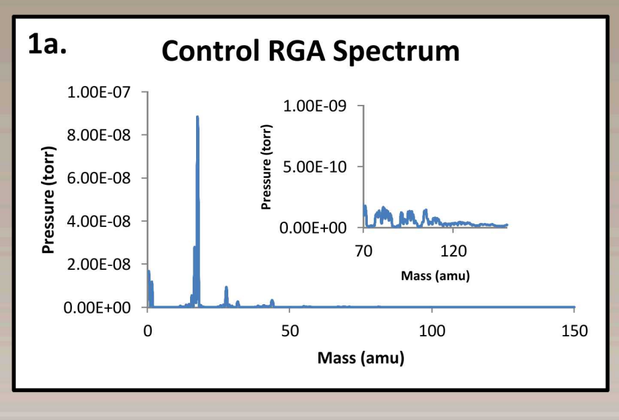
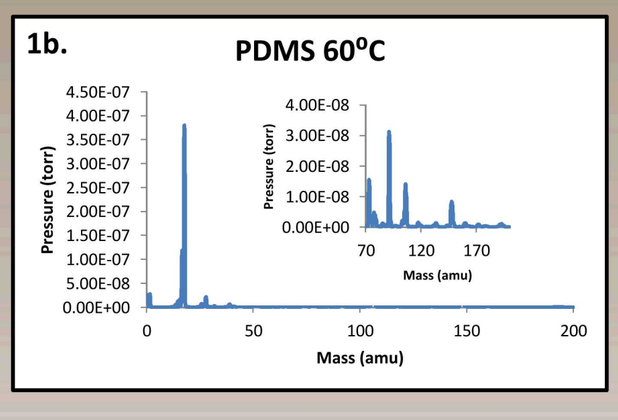
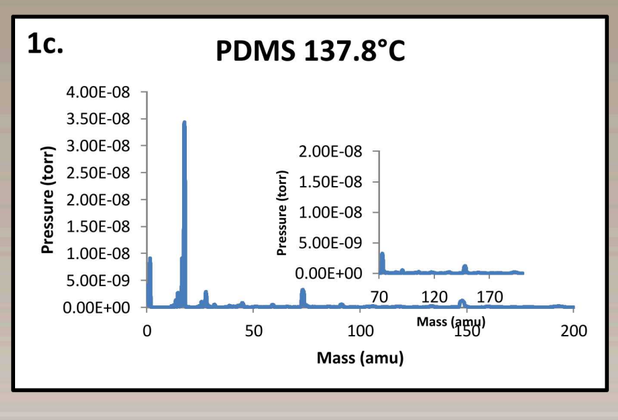
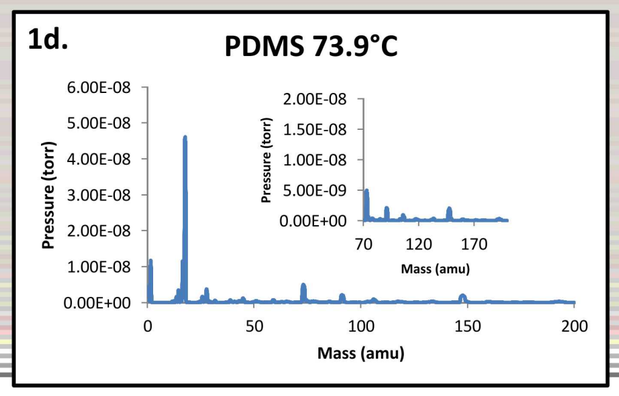
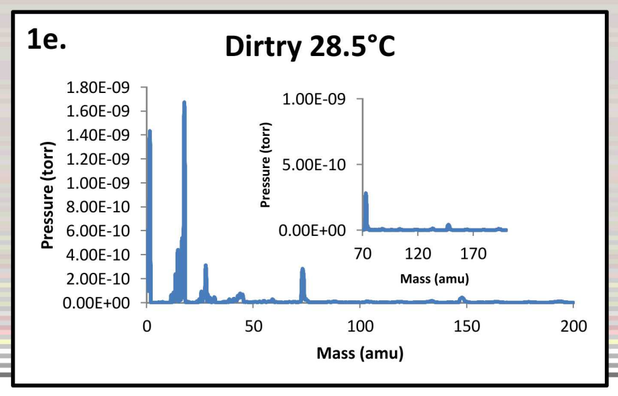
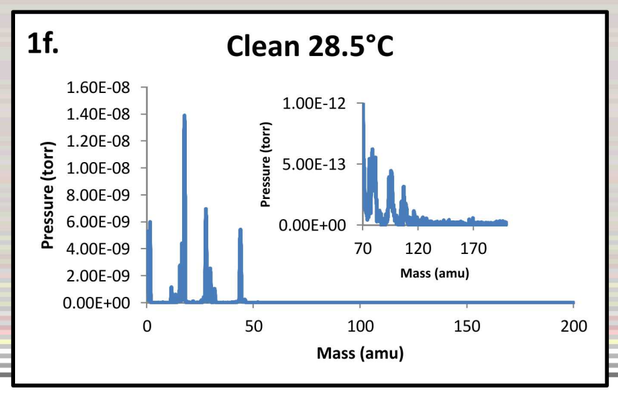


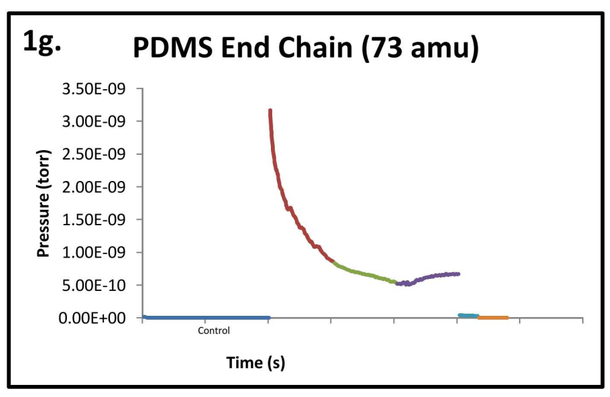


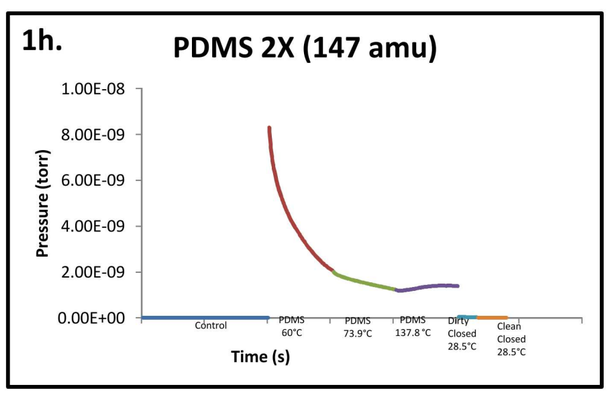




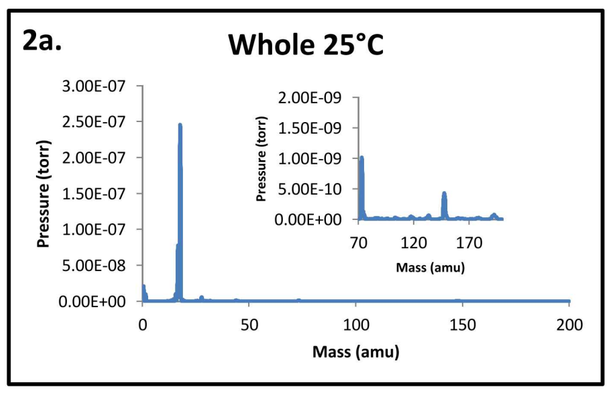


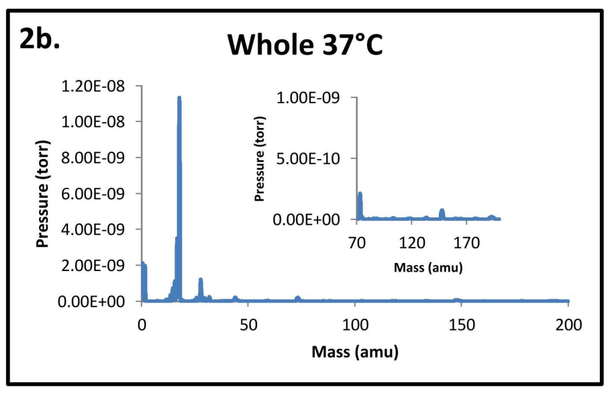


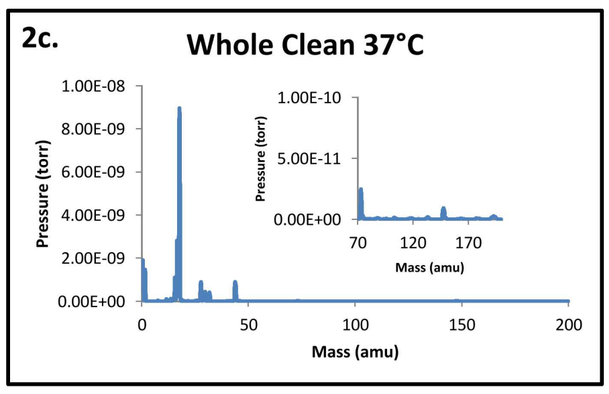


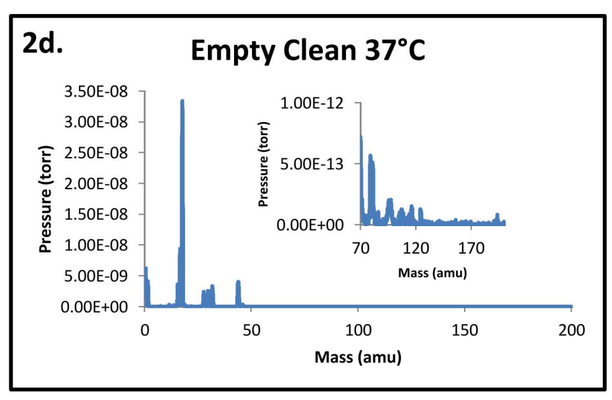


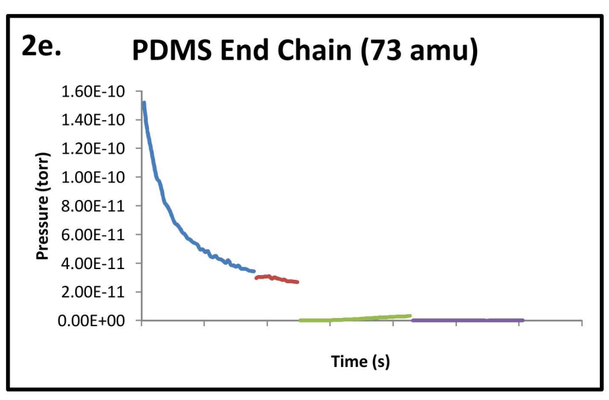
Figures 1g and 1h are partial pressure (torr) vs. time (s) curves of the two larges PDMS peaks (73 and 147 amu). These two plots follow identical trends. Increasing the temperature of the system effected the intensity of the PDMS peaks (Figures 1b-1d). However, only after plasma cleaning does the pressure drop completely below the minimum detectable partial pressure of 1E-12 torr (Figure 1f).

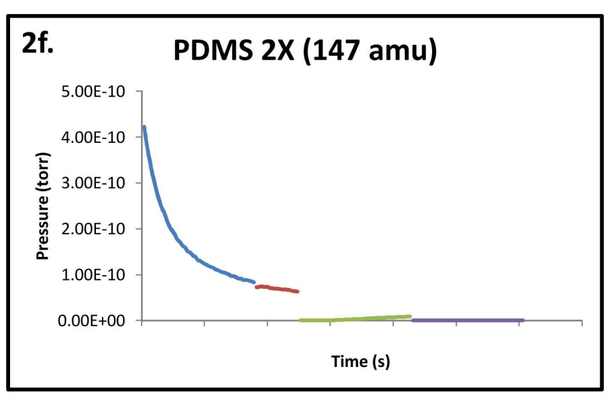












Figures 2e and 2f are partial pressure (torr) vs. time (s) curves of the two largest PDMS peaks (73 and 147 amu). These two plots follow the same trend. Increasing the temperature of the system effected the intensity of the PDMS peaks (Figures 2a-2d). However, only after plasma cleaning does the pressure drop completely below the minimum detectable partial pressure of 1E-12 torr (Figure 2d).

Conclusion and Future:

Though RGA is a qualitative approach to the problem addressed in the aforementioned experiments, it clearly reduces the intensity of the end chain (73 amu) and the short chain (147 amu) in RGA spectra. However, PDMS is a silicone and can be many thousands of chain lengths long, and RGA can only effectively identify gas molecules up to 300 amu in mass. These two complication makes it difficult to know whether or not heavy chains of silicone remain in the chamber. One possible solution lies in the use of quantitative surface analysis techniques such as X-ray Photoelectron Spectroscopy (XPS) or Auger Electron Spectroscopy (AES). It may also be useful to use a mass spectrometry technique like matrix-assisted laser desorption/ionization (MALDI) to detect heavier chains of PDMS.

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