Next GENERATION of EPITAXY

Plasma Source Conversion for Ultratech Inc. Savannah® ALD Systems

See disclaimer at bottom page

The Meaglow hollow cathode on a NW50 fitting, used for 300 Watt RF operation.

Testing of the hollow cathode plasma source with an oxygen plasma at 100 watts and 300 mTorr.

- **Lower temperature operation.**
- **Higher growth rates.**
- **Access new materials.**

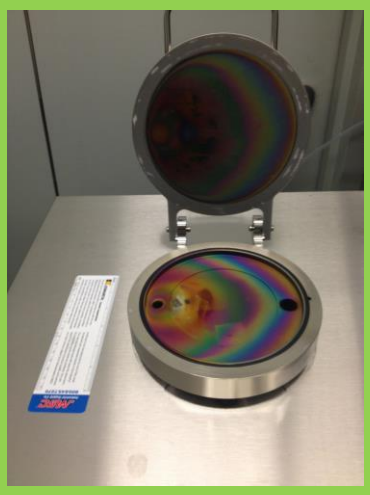
Why Convert?

Meaglow has now successfully converted a number of Ultratech Savannah®[1] ALD systems to plasma operation. The company has vast experience with the design and build of prototype plasma sources and has developed an effective hollow cathode plasma source design that can be used for integration into existing systems.

The conversion has now evolved to a standard offering with the advantage of higher growth rates, higher reactivity and lower temperature operation than for a standard thermal ALD system. Various publications show the advantage of plasma sources over thermal ALD operation, see for instance [1,2].

The hollow cathode sources are extremely robust and can be integrated into the lid of the Ultratech Savannah® device. Meaglow

Box 398, 2400 Nipigon Rd, Thunder Bay, Ontario, P7C 4W1, Canada
+1 (807) 252-4391, info@meaglow.com



Deposition pattern of Ultratech Savannah® 100 device before conversion.

Ultratech Savannah® 100 device conversion used for improved oxide deposition for US government lab.

supplies a new lid for this purpose. In contrast, an ICP source, with its dielectric quartz or alumina window, is too delicate to be mounted on a part that undergoes this constant movement. The Meaglow solution is therefore simple and effective, with minimal disruption to the Ultratech Savannah® device.

There are two different ways a conversion of this sort can be done. One method is to create a large area plasma source near the face of the deposition area. However, the manufacture of the plasma source can be expensive in this case. Meaglow has used the alternate approach of distributing the plasma from a smaller source. A similar design is used for some other plasma based systems. This adds volume to the deposition system and may alter the gas requirements of the Ultratech Savannah® device.

Meaglow provides a VCR connection for gas flow through the plasma source, however at low operating pressures (~ 300 mTorr and lower) the plasma will extend over the full deposition area so that flow through the source may not be needed. The normal gas delivery of the Ultratech Savannah® system may operate adequately in this case. At higher pressure the plasma will be confined higher in the source, in this case a separate flow through the plasma source may be required though radical distribution may be okay even in this situation.

What's needed?

- For the Ultratech Savannah® ALD system conversion, water cooling of the plasma source is required, 1-3 Litres per minute supplied to two 1/4" Swagelok connectors. The water supply is best near room temperature, and distilled water is preferred, though not absolutely necessary.
- A 13.56 MHz RF generator, a matching box and matching box controller are required. Meaglow can supply these on request or existing equipment may be suitable – discuss with Meaglow staff.

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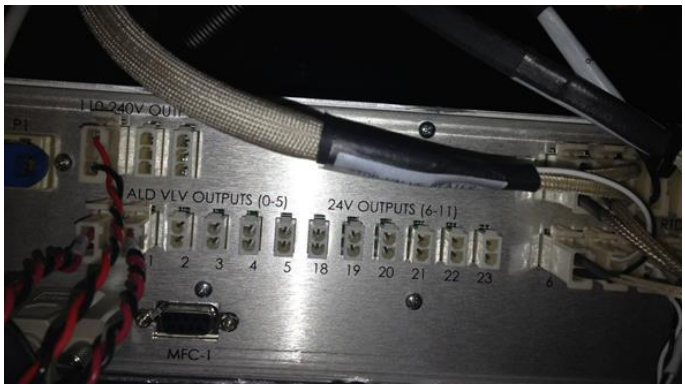
Ultratech Savannah® 200 device conversion. The plasma source is mounted to a new lid, which replaces the existing lid. The old thermal configuration can be recovered by simply putting the old lid back in place.

- An available connection for controlling the RF generator.

Meaglow can provide a box for mating a suitable control line to the RF generator for on/off control of the RF using the existing software. A number of outlets may be available, dependent on the Ultratech Savannah® device. 24 volt, 5 volt and mains voltage outlets are present on Ultratech Savannah® ALD systems, one of these may be available for use. See image below.



- A good ground connection of the Ultratech Savannah® system is needed for proper RF shielding. Proper RF shielding is imperative for personal safety and to stop RF interference of other nearby equipment. Some discussion with Meaglow staff may be needed to achieve optimum grounding.

Can Meaglow convert other ALD systems?

Yes, Meaglow has carried out a number of custom conversions for customers such as the University of Texas (Dallas), ALD Nanosolutions and Georgia State University. We also routinely convert Ultratech Fiji® ALD systems from ICP to hollow cathode operation, with the main advantage of greatly reduced oxygen contamination [3].

[1] H. B. Profijt, S. E. Potts, M. C. M. van de Sanden, and W. M. M. Kessels, J. Vac. Sci. Technol. A **29** (2011) 050801.
[2] Jan Musschoot, Ph D thesis '*Advantages and challenges of plasma enhanced atomic layer deposition'* University of Ghent, 2010-2011.
[3] C. Ozgit-Akgun, E. Goldenberg, A. Kemal Okyay and N. Biyikli, J. Mater. Chem. C **2** (2014) 2123.

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