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Etch Chamber Performance and Influence of Turbo Pump Conductance Path

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Abstract- Etch Chamber which use Silane Nitride Seasoning during Process has a common issue of Drift in Chamber pressure over a period of time resulting in Chamber failure. Apart from that, there are issues like Chamber to Chamber matching. Normally, the solution for this issue is to increase the foreline temperature, but after detailed study of turbo and its internal feature, it was identified that the internal features of Turbo Pump is Critical. The effect of Turbo pump on chamber performance can be resolved by changing the turbo operating temperature and its testing method

Keywords- Etch Chamber Performance, Chamber pressure, Turbo Pump and Vacuum Chamber.

I. INTRODUCTION OF PROCESS

Etch Vacuum chamber has been using A1 series Turbo pump from a Turbo pump supplier. Under the operating conditions, the Chamber pressure can be stable but with increase in the Process runs, the chamber pressure will be unstable and the Foreline pressure starts drifting up.

As seen in Chart 1, the data was collected on several chamber and the Performance of chamber is not stable. This results in Chamber matching issue and eventually chamber performance issue. To add salt on the wound, a new Seasoning step was included in process recipe.

Inclusion of Seasoning step resulted in Thicker layer of chamber deposition and Post process removal. Thickness of Deposition was 1.5 kA thick Silane Nitride layer. Further, high gas flow during alternate steps added oil to fire. After using the chamber for about 5-6 months, we could see a drift in the performance of the turbo (refer Chart 1). Steep drift of pressure resulted in Chamber fault due to which we had to replace the Turbo pump frequently. The issue would repeat after 6 months of usage.

Detailed Study

Initially the issue was attributed to Operating temperature of turbo pump. This is because there was no Byproduct deposition in the heated foreline. The fore-line gets heated to 110º C, while turbo pump was heated to 85ºC.

Byproduct built on Fore- line and Turbo outlet were analyzed and found to be $(NH_4)_2SiF_6$ (Fig 2a). The sublimation temperature for this material is ~105º C. Thus, a need for High temperature Turbo arose. Even though we had a direction to go towards High temperature turbo, one question was still unanswered. Why would Type 1 series turbo on Few chamber survive the Seasoning step where as Type 2 series failed in 6-8 months?

We worked with Supplier design team to answer the above question and to study internal structure of their Turbo pump. After an extensive study, the root cause was attributed to Conductance path for Gases. The Angle of blade in type 1 series were slightly different than the Type 2 Series.

However, Type1 and Type 2 series has same performance for other gases like H_2 or N_2 but its performance changes with Sublimation temperature of Byproduct. This change in angle would reduce Gas flow path and there by results in Byproduct build-up (Fig 4).

Based on this, Turbo supplier modified Testing methods on their Turbo to include O2 gas and Ar Gas. This helps to compare the Conductance of different gases at several base pressure and reduce variability

Two Turbo pumps were tested in Etch chamber and no drift in chamber pressure was observed after multiple Marathons.

Further, these Tubo pumps were inspected the internal Buildup using a borescope camera and found the turbo free from any Byproduct buildup.

With this successful evaluation, the new High temperature Turbopump with high conductance was released as a part of production tool.

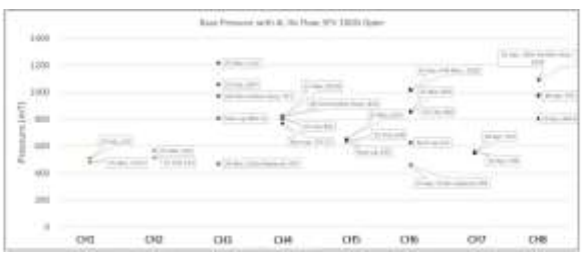

Figure 1: Chamber Foreline Pressure on several chambers

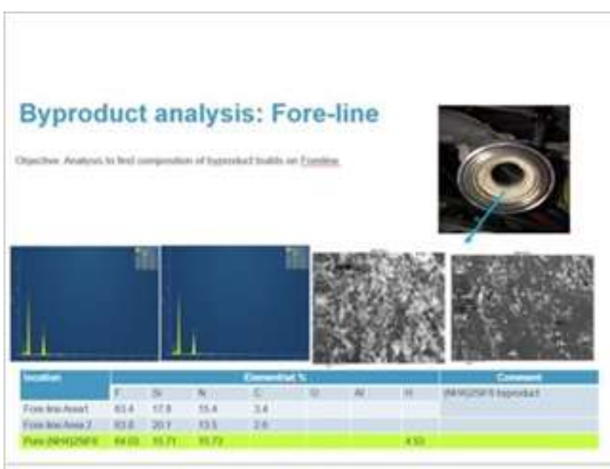

Figure 2: Fore-line Deosition

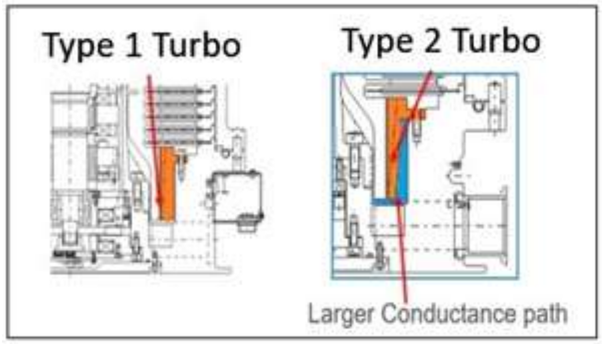

Figure 3: Conductance path

II. CONCLUSION

The Influence of Conductance path on Chamber performance is High. Further, standard Turbo manufacturer uses few gases (H2 and /or He) to plot the turbo performance graphs, which might not give complete data . Hence Study if pumping curves at different pressure and flow becomes critical

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