

# REALIZING, INTEGRATING, AND QUALIFYING VACUUM MECHATRONICS

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Vacuum compatibility of mechatronic systems is a very important system requirement that has not only a huge impact on design but also on realization, integration, and testing of the system. This means the vacuum performance should be assured by:

- Choice of Concept
- Design (Practical)
- WOW

Contamination is a threat to the vacuum compatibility and therefore the overall performance. Before producing, assembling and integrating a mechatronic vacuum system a WOW needs to be defined and strict compliance to the procedures needs to be guaranteed.

In most cases the vacuum specification are determined by the application, in terms of maximum (partial) pressure. From this specification and the expected pumping capacity a vacuum budget can be defined. This budget contains the outgassing specifications per module or component. Controlling the project by such a top down vacuum budget enables to divide the project into sub-modules but also to make bottom up choices if needed. This budget is the "blueprint" used during the realization and assembly of the system.

Processes, e.g. e-beam or EUV, are often generating high-energy and are influencing the material outgassing and therefore overall performance. These effects can even damage the system and should be taken into account in the total vacuum strategy. It is often very difficult to create representative process conditions during vacuum qualifications of modules. To keep the realization qualification feasible and affordable, in certain cases some "controlled" risk need to be taken.

Current semiconductor Lithography roadmap identifies Extreme Ultra Violet Lithography (EUVL) as the new production technology from the 32nm technology node and beyond. The introduction of this 13.5 nm wavelength technology has huge impact on the tool design and its operating environment. Requirements to the system environment are driven by risk off

reflection loss to the optics. Among other strategies a high vacuum environment is essential to operate this tool. As a co-developer of ASML, Philips Applied Technologies has been responsible for the design, realisation, and integration of a significant part of the ASML EUV alpha-demo tool.

As part of the strategy in this project we have chosen to use Residual Gas Analysis as one of the means to determine possible contaminants en qualify modules. This qualification takes place in several steps e.g.:

- Qualify basic materials, cleaning methods and components.
- Qualify components.
- Qualify assemblies.
- Qualify the total system.

Leak testing is also a qualification repeatedly needed to qualify modules. Even with components purchased from renowned vacuum companies these standard leak test are often proven not to be reliable. Lots of extra tooling, infrastructure and sometimes even design changes are needed to enable leak tests and Residual Gas Analysis.

The production of components e.g. the EUVL Base Frame, Electrical and optical feed-throughs constitute a practical example of the WOW chosen for a typical precision engineering vacuum products.

Current and future Competence development within Philips Applied Technologies is, among tribology and thermal aspects in vacuum, strongly focusing on defining a simpler and more economic WOW and pragmatic qualification methods that are more compliant with the application processes.

**Key Words:** Qualification, Cleaning, RGA, System integration, WOW.