Quick Release for a Vacuum Viewport

By Team V.O.I.D.

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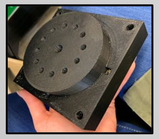
Problem Statement

ASML Cymer has one of the most advanced EUV lithography system in the world creating MEMS devices on a new scale. They require a way to quickly attach and detach a vacuum viewport while still being able to maintain a vacuum seal of at least 10^-2 Torr. The design needs to be one handed for ease of use and should mount/release within 15 minutes or less. Additionally, a metrology load measuring 10 cm long with a mass of 1 kg should be able to mount easily.

Prototype Process

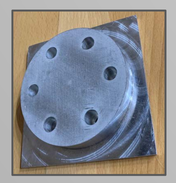
Initial Prototypes

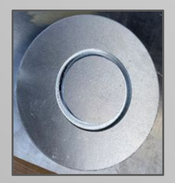


The first prototypes, made of styrofoam, wood, and PLA, featured a custom inner groove to lock the top and bottom parts in place.

The early prototype testing lead to redesigns of both top and bottom parts

Final Designs

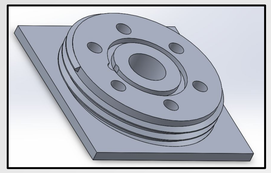




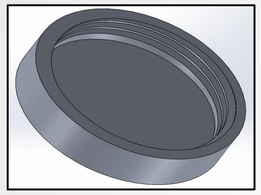
The final designs included counterbores to interface with the vacuum chamber's bottom plate. The inner groove lock was replaced and several o-ring grooves were added.

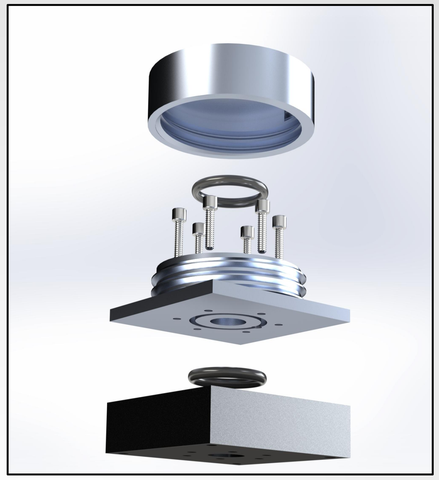
CAD Design - Exploded View

V001 - Bottom Plate



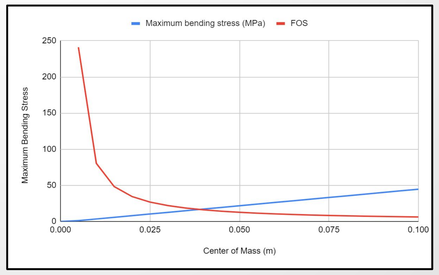
V002 - Top Plug



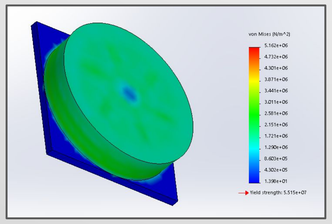


Design Analysis

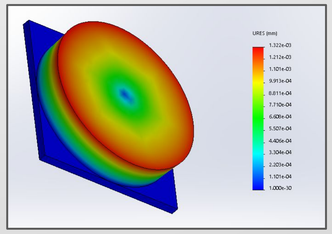
The graph shows the relation between the center of the added mass to the maximum bending stress. The position with the highest amount of bending stress yielded a minimum FOS of 6.17



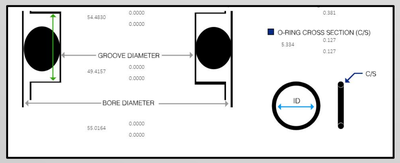
Stress Analysis using applied maximum torque

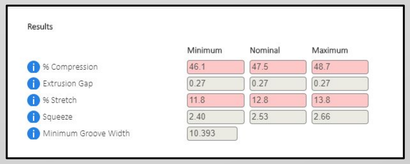


Displacement Analysis using Maximum Torque



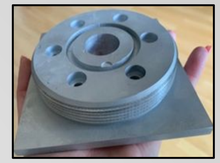
Soft Viton O-ring Analysis





Final Product

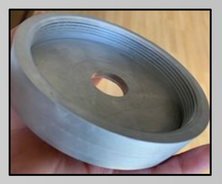
V001
Bottom Plate



V002
Top Plug

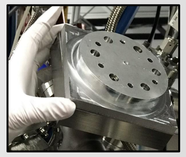
V003
Top Plate with Center hole

V003
Internal View

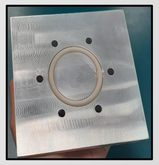


The final design for the viewport lock includes two separate top parts V001 and V002. Part V001 serves as a simple plug whereas V003 can be used to interface the viewport with any desired metrology. In order to ensure a vacuum seal of a minimum 10^{-2} torr, three soft viton o-rings were used.

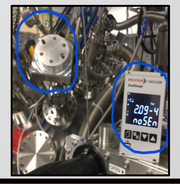
Tests



Test 1:
- Failed the alignment test
- Noted need for better finish



Test 2:
- Passed the alignment test
- Failed the vacuum test due to too large O-ring groove



Test 3:
- Passed the alignment test
- Passed the vacuum test

All tests were conducted at ASML-Cymer

Design Advantages

Exceeds requirements	• Holds a vacuum seal of 10^{-6} torr • Provides a 2.02 FOS
Fast	• Takes less than 10 seconds to lock
Easy to use	• Can be locked and released single handedly
Cost Effective	• Costs $4,000 less than allotted budget

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