MEMS Device Cleaning

Cryogenic CO_2 Applications Note 011A

Introduction

Cleaning is an essential process for MEMS applications in order to prevent device failure due to foreign material. Small particles located on MEMS devices are significant causes of device rejection and yield loss. These issues affect inertial devices, such as accelerometers and gyroscopes, as well as microphones, laser bars and other MEMS devices.

Particulate contamination can also be a source of yield loss for backend/assembly MEMS processes. Removing contaminants during these process steps is critical for improving yields and device reliability. Wafer level dicing and poor environments are possible sources of particulate contamination during back end of line (BEOL) processes.

Wet cleans are often found to cause stiction issues with MEMS devices and mega sonic cleaning can often impart unwanted device damage due to the high energy associated with this process. As a result, Cryo CO_2 cleaning provides a good solution for many MEMS cleaning applications.

CO_2 Cleaning

The Cryogenic CO_2 cleaning process uses CO_2 snow to clean substrates in an extremely fast and environmentally friendly, all dry method. The cleaning is primarily mechanical, with momentum transfer from the CO_2 snow to the unwanted particles providing the energy for the process. Cryo CO_2 cleaning processes are a particularly good fit for the MEMS accelerometer market, since they can perform gentle to aggressive cleaning on wafers or packaged devices.

Processes are developed specific to a customer's application based on years of process knowledge and experience. All of our production processes provide solutions that are cost effective, non-destructive, and waste/residue free. Additionally, the all dry nature of the process provides stiction-free cleaning, so that moving parts on the substrate are not negatively affected by the CO_2 snow.

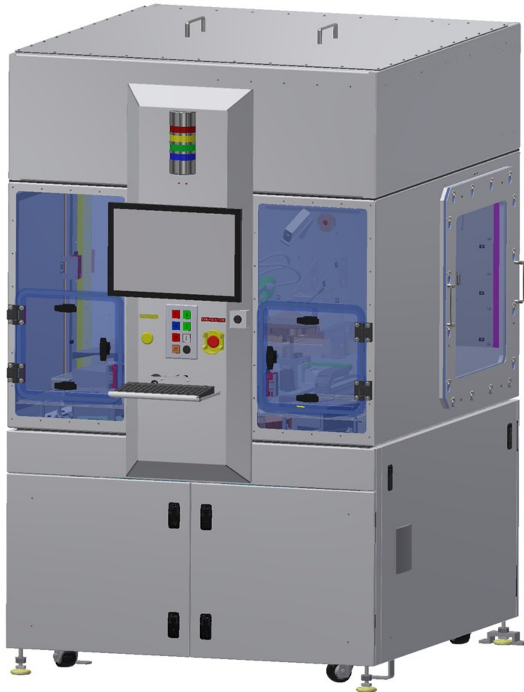
Wafer Clean 2200 System

The Bruker WaferClean® 2200 System is the ideal processing system for implementing CO_2 cleaning into a production line. The system is a fully automated, stand-alone system that provides cassette to cassette substrate handling into our environmentally controlled, low particulate processing chamber. The user interface is through a color monitor where our easy to use software is accessible and can be configured to your specific process requirements.

Other system features include:

- Advanced environmental control,
- Failsafe system monitoring,
- High uptime and performance,
- Proven process results,
- Sophisticated CO2 delivery, and
- A large number of options to customize your system,

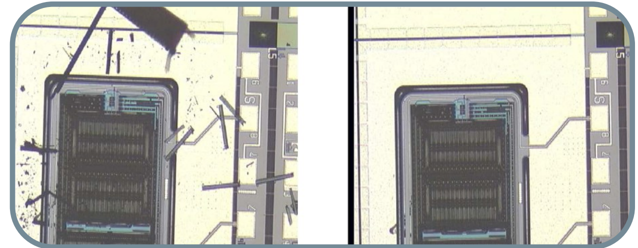
A picture of the WaferClean 2200 is shown below:



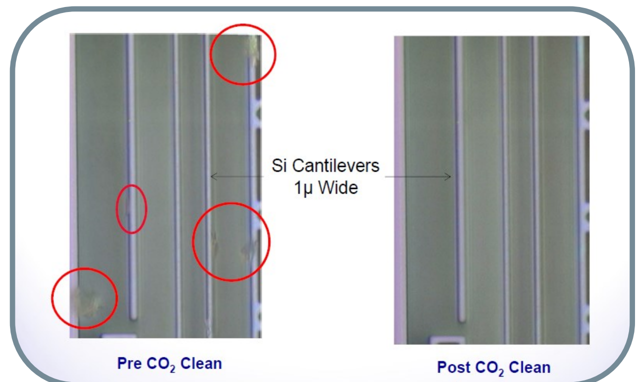
Process and Results

Wafer Level Processes

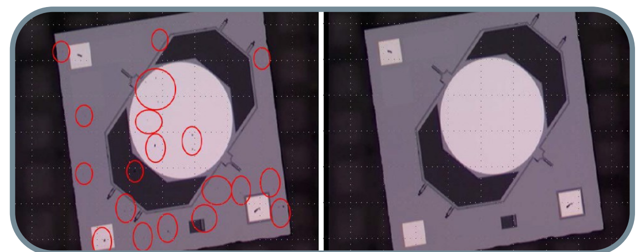
There have been many cleaning processes developed using Cryo CO_2 technology for MEMS devices. Examples of these are shown below. In all photos below, the left photo is before cleaning and the right photo is post-clean.



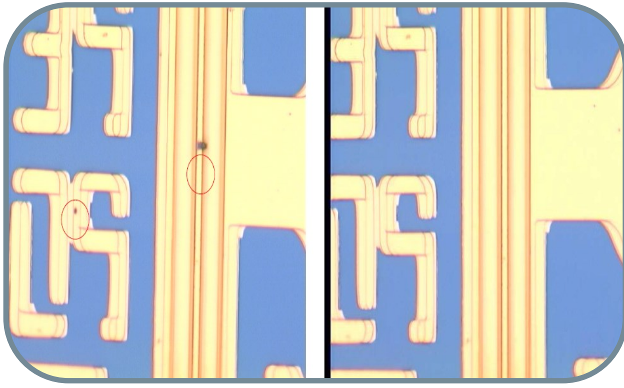
MEMS accelerometer. Large scratch on the left photo was cleaned up completely using Cryo CO_2 technology.



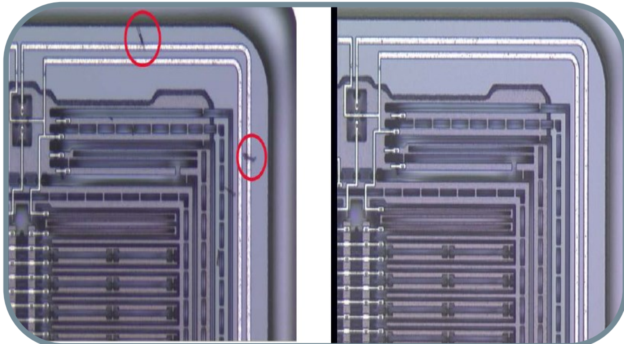
MEMS Cantilevers: The released structures are cleaned without damage using Cryo CO_2 processes.



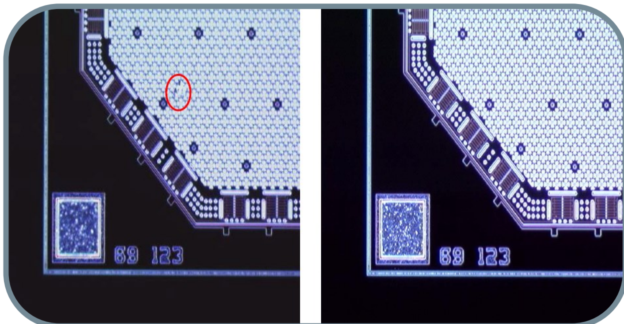
Digital Light Switches: All of the defects in the red circles on the left are removed with Cryo CO_2 cleaning.



Laser Bars: Particles shown in red circles are removed with Cryo CO_2 methods.



MEMS Accelerometer: Particles are removed from dense device without damage.



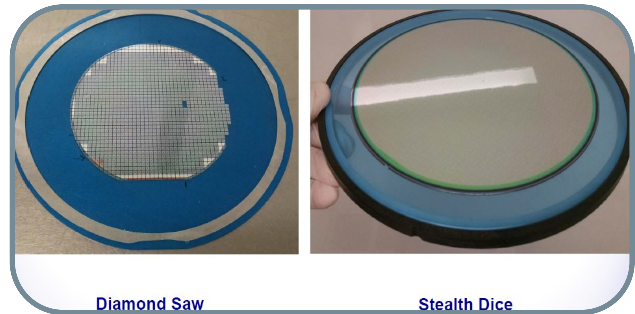
Pico microphone: The delicate membrane of the microphone is cleaned without damage using Cryo CO_2 processes.

In all of the above cases, the devices are clearly cleaned without damage using Bruker's Cryo CO_2 technology.

Back End of Line Processes

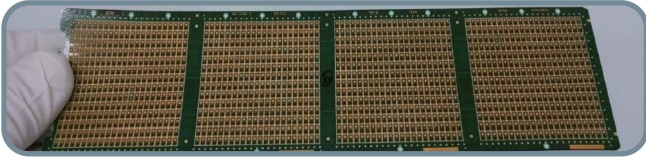
Packaged devices have also been easily cleaned using Cryogenic CO_2 technology. An example is shown below. Here, the left photo shows many defects (circled in red), while all of the defects are eliminated after Cryo CO_2 cleaning, as shown in the right photo.

Similar positive results are seen with other BEOL non-wafer configurations. Examples of these are shown below.



Post Diced Wafers: Still mounted on dicing tape

Individual die mounted in Gel-Paks



Die mounted in lead frames

Conclusion

Bruker's Cryo CO_2 cleaning processes are ideal for MEMS manufacturing, due to their inherent cleanliness, flexibility to work with different MEMS wafers and devices and proven performance in many different applications.

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