

The Cleanroom Environment

A brief overview

The manufacture of optics requires a clean, dust free environment throughout the process. Dust contamination can affect the polishing process by causing scratches on the optics, while dust contamination during the coating process, while the optics are being prepared for coating, can lead to dust inclusions in the optical coating, thereby rendering an expensive optical component worthless.

Any reader who has ever visited a semiconductor manufacturing plant cannot fail to be impressed by the extensive cleanroom facilities that such factories have. In general, a cleanroom can be described as an environment with a low level of pollutants, in the case of optical coating manufacture dust particles.

Outside, under the open sky, a typical cubic metre of air contains between 30 and 40 million dust particles of 0.5µm diameter or larger. It becomes immediately apparent that such an environment is unacceptable for the manufacture of precision optics. Hence, an environment needs to be created that reduces dust contamination to a suitable level.

ISO14644-1 is an international standard that defines nine classes of cleanrooms, with class 1 being the highest and class 9 the lowest standard. The standard defines the number of particles per size allowed within one cubic metre of air. While many newer specifications refer to ISO14644-1 when specifying a manufacturing or packaging requirement, older drawings often refer to an old US standard (US FED STD 209E) which was cancelled in 2001. To allow cross-referencing, table 2014-01a below lists the equivalent of the old US standard in relation to the ISO standard.

Class	maximum no. of particles/m ³						FED STD 209E equivalent
	≥0.1µm	≥0.2µm	≥0.3µm	≥0.5µm	≥1µm	≥5µm	
ISO 1	10	2.37	1.02	0.35	0.083	0.0029	
ISO 2	100	23.7	10.2	3.5	0.83	0.029	
ISO 3	1000	237	102	35	8.3	0.29	class 1
ISO 4	10000	2379	1020	352	83	2.9	class 10
ISO 5	100000	23700	10200	3520	832	29	class 100
ISO 6	1x10 ⁶	237000	102000	35200	8320	293	class 1000
ISO 7	1x10 ⁷	2.37x10 ⁶	1020000	352000	83200	2930	class 10000
ISO 8	1x10 ⁸	2.37x10 ⁷	1.02x10 ⁷	3520000	832000	29300	class 100000
ISO 9	1x10 ⁹	2.37x10 ⁸	1.02x10 ⁸	3520000	8320000	293000	room air

Table 2014-01a: Cleanroom classifications as per ISO14644-1

Most coating chambers are single door chambers, which means that they get loaded and unloaded through the same door. This also requires the cleaning to be done from the room where the coating chamber is situated and loaded/unloaded.

The protective shields inside a coating chamber get coated during the normal production process and therefore require regular removal and cleaning. During the removal it is unavoidable for coating particles to flake off the shield surfaces and increase the dust contamination inside the coating department. Hence, care must be taken to avoid contamination of other parts of the department.

For this purpose, optics are cleaned and stored within the department in laminar flow cabinets. These are enclosed benches, where air is drawn in through a particle filter

(generally situated above the bench or behind it) and blown towards the user in a smooth, laminar flow (vertical or horizontal, depending on type of cabinet).

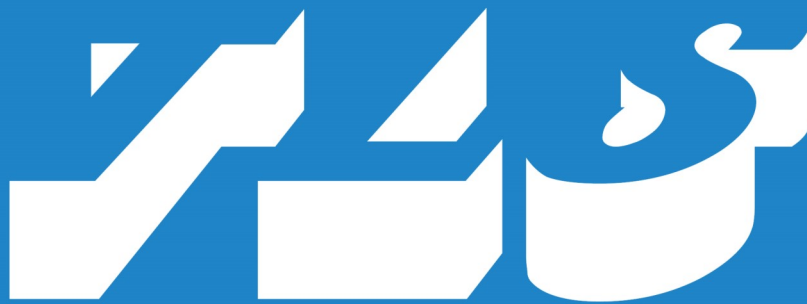
Typically, laminar flow cabinets are available in cleanroom classes of ISO 4 or ISO 5. When operating laminar flow cabinets it is important to follow the manufacturer's requirements on maintenance. These usually ensure that the filter and air intake seals are regularly checked and that the filters are cleaned/changed at regular intervals to maintain the required cleanliness standard.

In practice, a critical interface is the process of loading the optics into the coating chamber prior to coating. During this process, the optics are being removed from the laminar flow cabinet and positioned into their respective positions in the calotte within the coating chamber. To minimise the risk of dust settling on the optics surface and then getting embedded in the coating during the coating process, it is important that particular care is being taken during this step. The optics need to be transported in an enclosed box and the surfaces protected by caps, which are only removed immediately prior to closing the coating chamber door and putting the chamber under vacuum.

During the cleaning of the optics, which will be covered in a separate technical note, it is important that the correct materials such as lint free cleaning tissue and chemically pure cleaning solvents are being used. A thorough inspection of a cleaned optic, usually under a bright halogen light against a black background, is also vital.

References:

BS EN ISO 14644-1:1999, Cleanrooms and associated controlled environments, Classification of air cleanliness, ISBN 0 580 32951 8



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