



Basic requirements of cleanroom garments

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Basic requirements of Cleanroom garments

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Roadmap

- ◆ Cleanrooms
- ◆ Essential requirements of cleanroom garments
 - ◆ Linting
 - ◆ ESD-performance
- ◆ Textile materials and garment design

Cleanrooms

◆ What:

- ◆ Areas with specified number of particles per unit volume

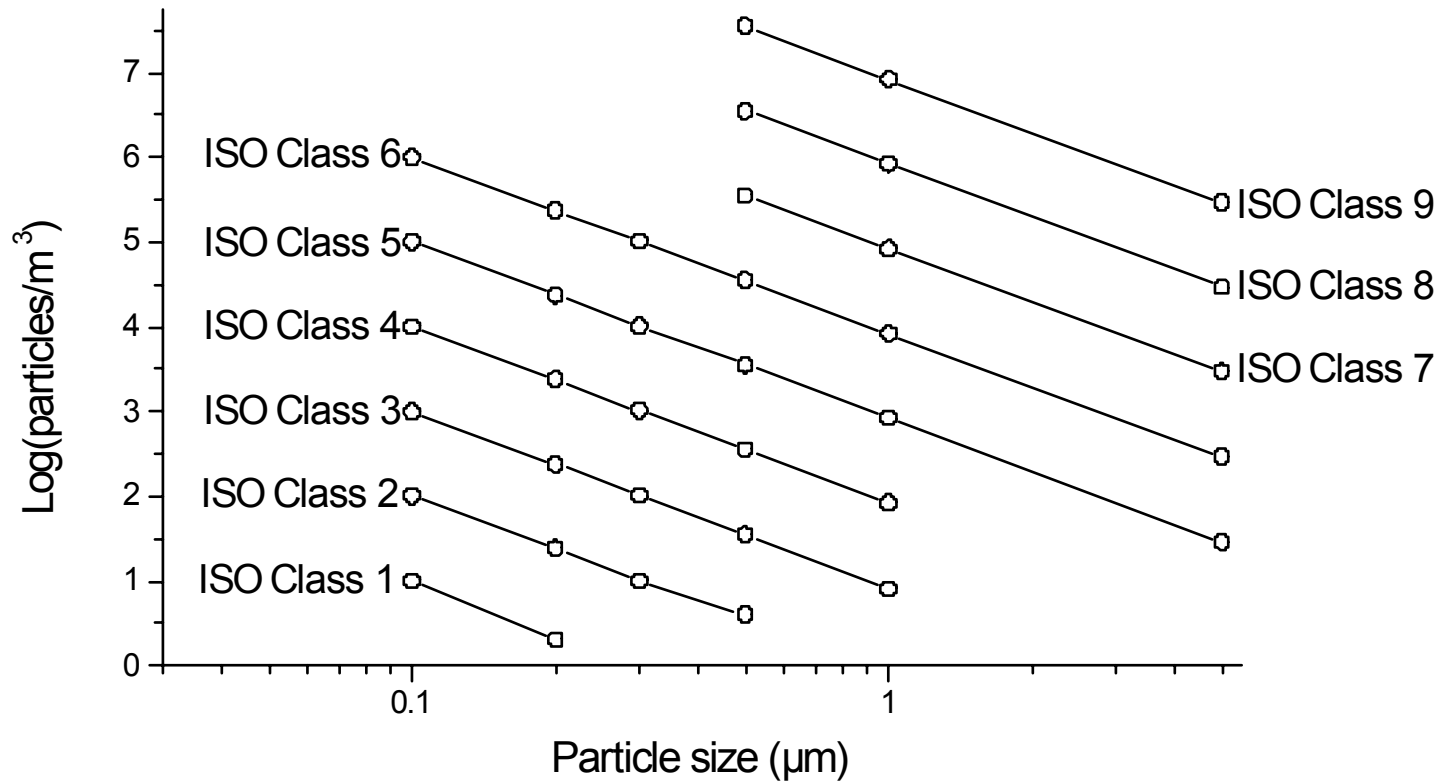
◆ Where:

- ◆ Microelectronics industry
- ◆ Pharmaceutical industry
- ◆ biotechnological industry
- ◆ Food & beverages



Cleanrooms classification

ISO 14644-1





Classification versus activities

◆ ISO 4:

- ◆ High speed video duplication
- ◆ Glass lamination

◆ ISO 3

- ◆ Compact disk manufacturing
- ◆ Optical manufacturing

◆ ISO 2

- ◆ Semi-conductor manufacturing
- ◆ Pharmaceutical products

◆ ISO 1

- ◆ Latest wafer and chip manufacturing
- ◆ Hard disk manufacturing



Cleanroom garments

◆ Why necessary?

- ◆ Humans are broad-spectrum particle and aerosol generator
- ◆ Prevent contamination of cleanroom by cleanroom worker (barrier-function)

◆ Danger

- ◆ Garments can shed particles (linting)
- ◆ Garments can damage microelectronic components through ESD events



Particles generated by humans

Source	Classification	Type of contamination
Operator	Particulate	Skin flakes, hair, cosmetics
	Biological	Bacteria, viruses
Street cloths	Particulate	Silica dust
	Fibers	Cellulosic, ...
	Chemicals	
	Biological	Bacteria

◆ Skin flakes:

- ◆ average size: 20 μ m
- ◆ Number: 500.000 – 1.000.000/min moderate operation



Performance requirements

- ◆ Particulate barrier properties
- ◆ Garment cleanliness
- ◆ ESD performance

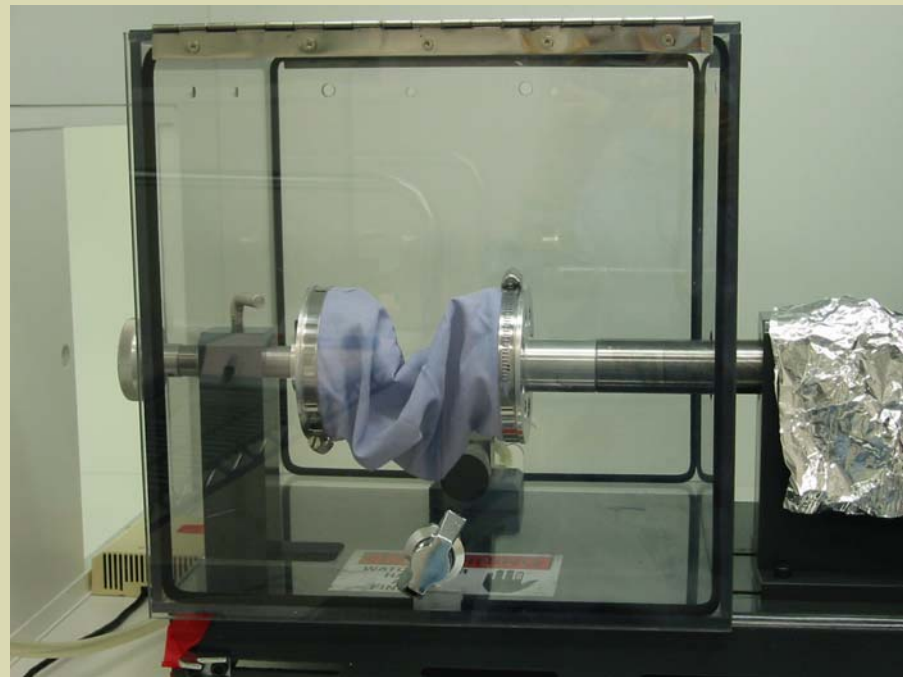
- ◆ Comfort
- ◆ Durability (sterilisation)

Garment linting

Helmke drum-test & Gelboflex

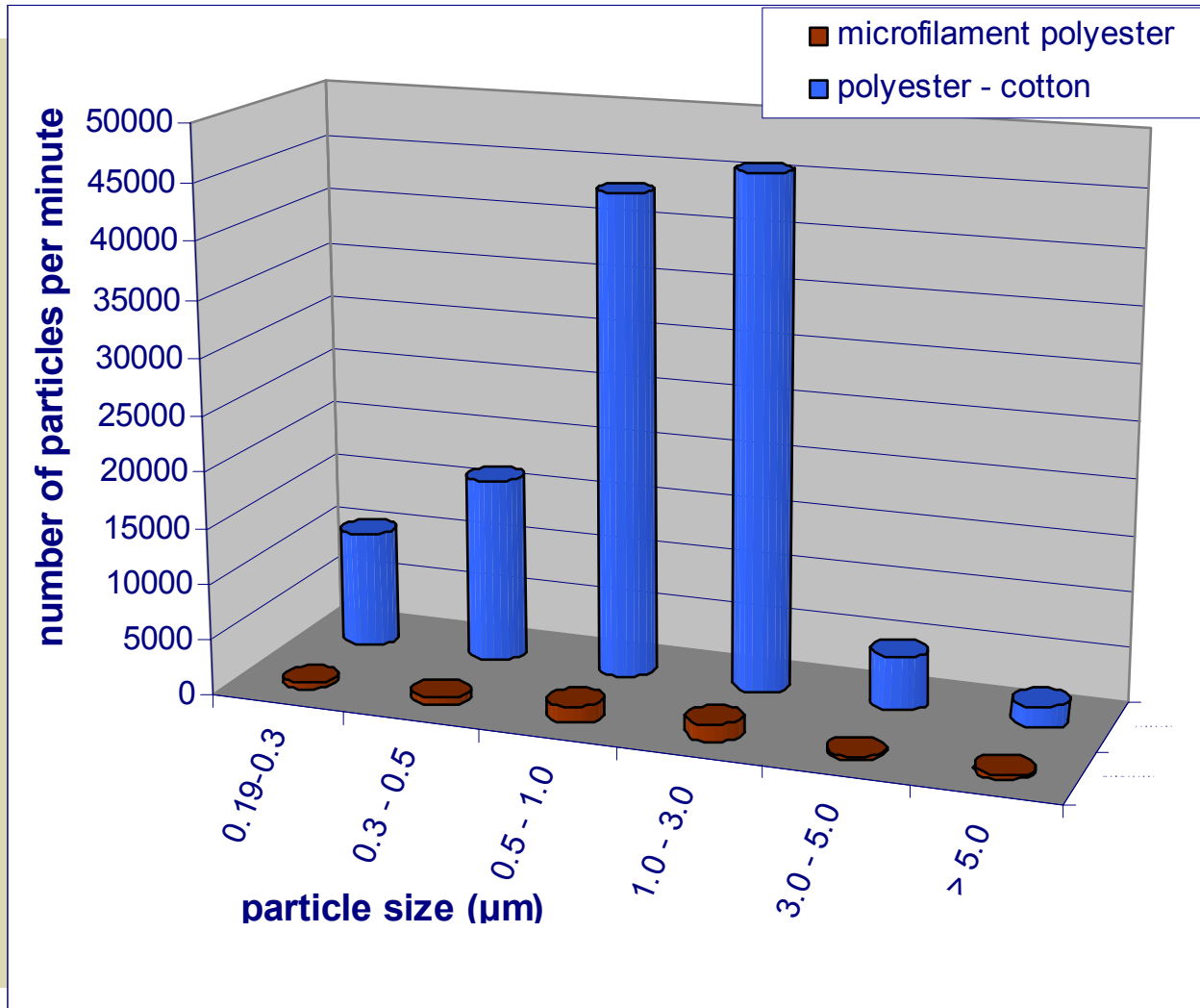


Helmke drum test



Gelbo-flex test

Linting propensity



Measurements

Cleanroom facilities in Centexbel





Cleanroom garments

Materials and construction

◆ Materials

◆ Reusable materials:

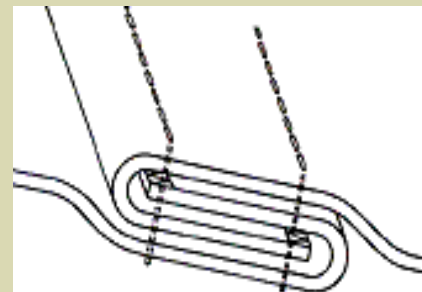
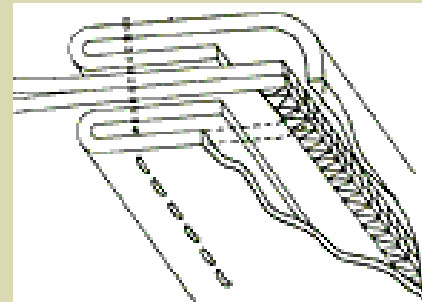
- ◆ Densely woven polyester material
- ◆ Knitted materials (less critical areas)
- ◆ Tri-laminates

◆ Non-woven materials

- ◆ Tyvek

◆ Construction

◆ Seams





ESD-failure of electronic components

◆ Failure rate

- ◆ 30-50% of all failures due to electrical overstress
- ◆ Decrease of component dimensions increases ESD sensitivity

◆ Failure modes

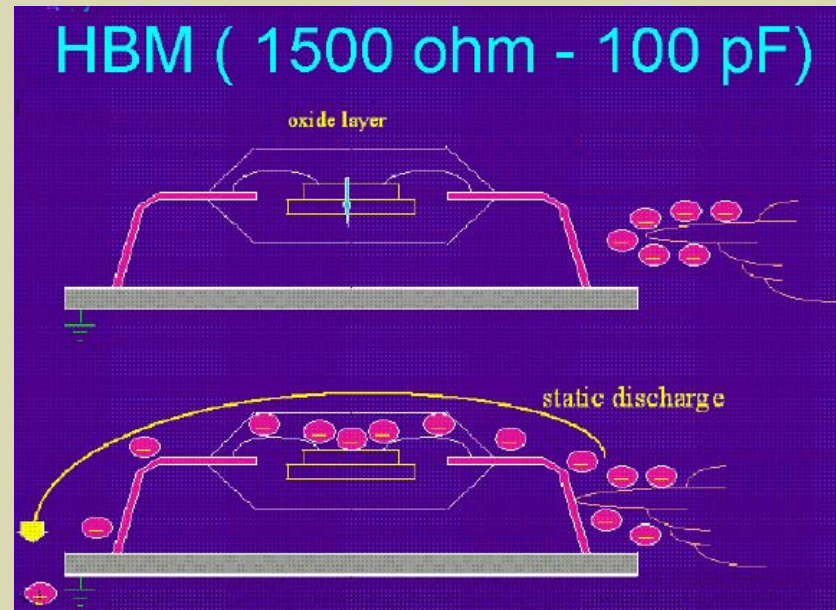
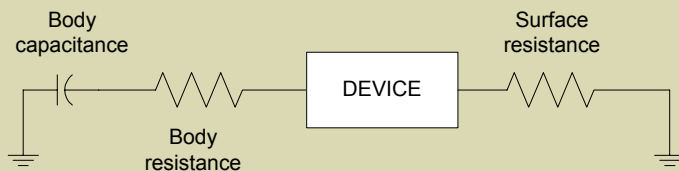
- ◆ Direct discharge from operators body (HBM)
- ◆ Discharge from a charged device to ground (DM)
- ◆ Discharge from a charged cleanroom garment



ESD performance

Failure modes of components

- ◆ Human body model
 - ◆ 0.1 – 10 A peak current
 - ◆ 100 – 200 ns duration



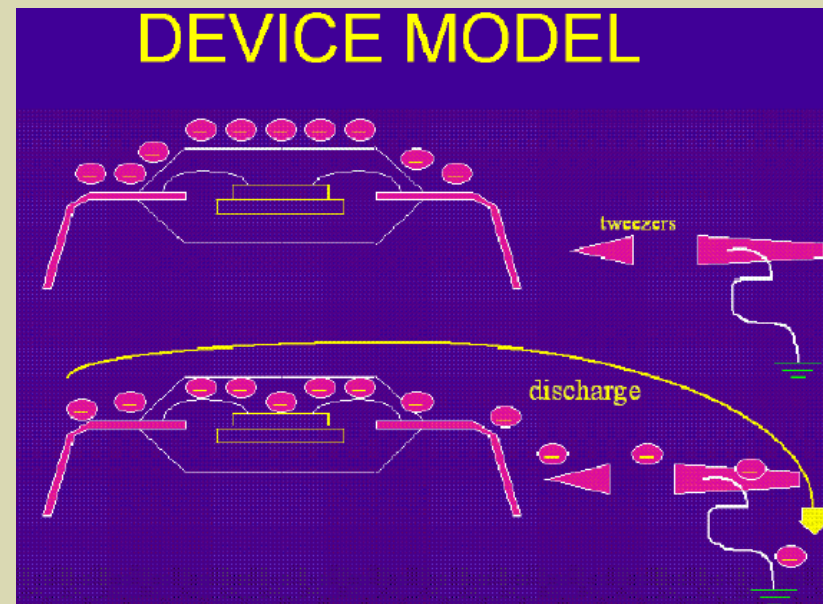
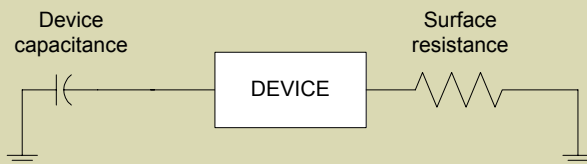


ESD performance

Failure modes of components

◆ Device model

- ◆ 5 – 10 A peak current
- ◆ 1 - 2 ns duration





ESD-performance

Sensitivity of electronic devices

Technology	Typical HBM sensitivity (V)
MR heads	10 – 100
Flat panel displays, CCDs	50 – 150
Laser diodes	200 – 1500
LEDs	500 – 8000



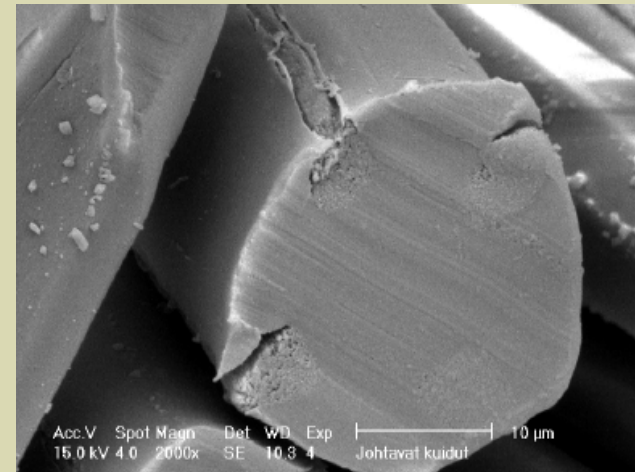
Requirements of ESD garments

- ◆ Garments should:
 - ◆ Low propensity for triboelectric charging
 - ◆ Low resistance for fast dissipation in order to avoid charge accumulation
 - ◆ High resistance to slow down the charge decay and to limit the energy transfer in a discharge
 - ◆ Total suppression of E-fields from charge on clothing

Cleanroom garments

ESD-measures

- ◆ Material design
 - ◆ Conductive yarns
 - ◆ Gridstructures (5 by 5, 2 by 2 mm)
- ◆ Garment design
 - ◆ Electrical conduction garment
 - ◆ Earthing of the operator
- ◆ Cleanroom design
 - ◆ Conductive shoe wear
 - ◆ Earthed floor



Standard test methods



Point to point resistance according to IEC 61340-5-1



Standard testmethods

- ◆ Standard testmethods are resistive measurements
- ◆ Originally developed for homogeneous materials – suited for inhomogeneous materials ?
- ◆ Charging propensity of material is not taken into account
- ◆ Effect of grounding is not evaluated



ESTAT project



◆ Aims to:

- ◆ Provide a basis for understanding charging and discharging behaviour of complete system (operator – clothing – environment)
- ◆ Study test methodologies and performance requirements for protective ESD garments

Project website: <http://estat.vtt.fi>



ESD performance requirements

<i>Garment class</i>	<i>Performance target</i>	<i>Required garment performance</i>
Class 1	Ultrasensitive devices	High protection level, special recommendations for grounding, undergarments etc...
Class 2	ESDS with $> 100\text{ V}$	Normal protection level corresponding to typical stat-of-the-art ESD garments
Class 3	ESDS with $> 200\text{ V}$	Low requirements for the electrostatic performance, some normal garments may pass the requirements



Conclusion

- ◆ Cleanroom garments:
 - ◆ A growing market
- ◆ But:
 - ◆ Stringent performance requirements