Further Improvements with Dry-Ice Cleaning on SRF-Cavities

Arne Brinkmann, Jens Iversen, Detlef Reschke, Jörg Ziegler
DESY D-22603 Hamburg/Germany

Abstract

Looking for advanced potentials to clean surfaces of superconducting accelerator cavities, a dry-ice cleaning method promises to be a useful additional application to the standard high pressure rinsing with ultra pure water.
Dry-ice cleaning using the sublimation-impulse method removes particles and film contaminations, especially carbon-hydrates, without residues. First cleaning tests on single-cell cavities showed Q-values at low fields up to $4x10^{10}$ at 1.8 K. Gradients up to 32 MV/m were achieved, but field emission still is the limiting effect. Further tests are planned to optimize the dry-ice cleaning technique.

❑ basic principle of srf cavity treatment:

avoid field emission limitation of cavities by thorough surface cleaning => no particles; no chemical residues

❑ state of the art:

final preparation by electropolishing/chemical etching + high pressure water rinse + assembly under cleanroom conditions
additional cleaning potential of dry-ice cleaning

❑ advantages of dry-ice cleaning

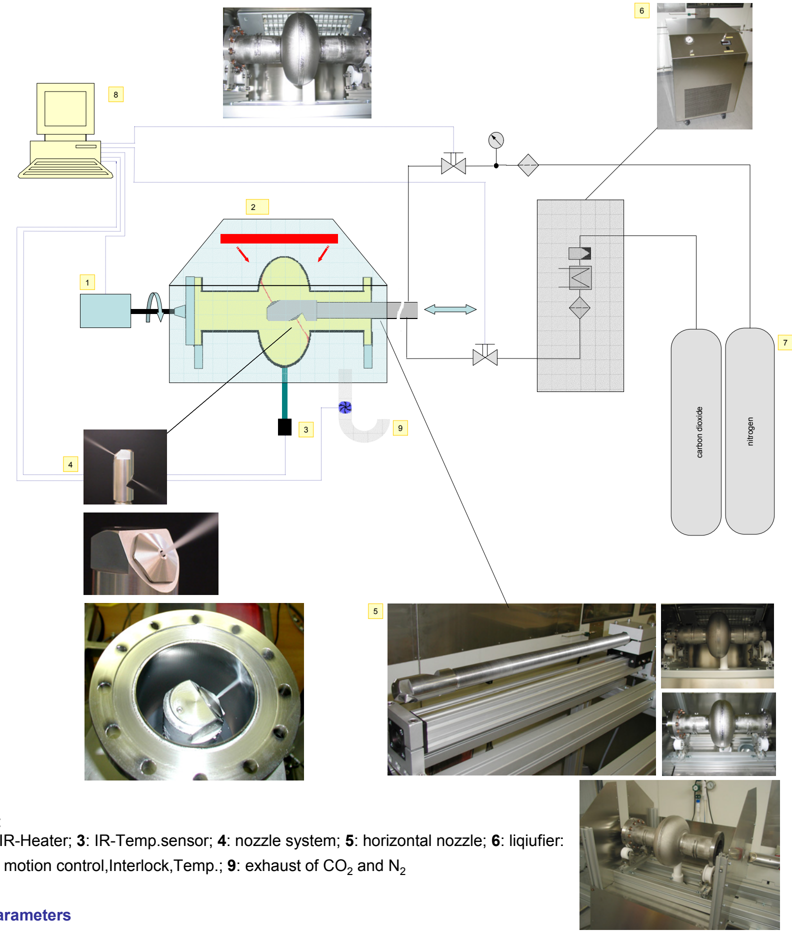
I. removal of particulate,film contaminations and chemical residues esp. hydrocarbons
II. dry cleaning process => no wet cavity surface
=> application to conditioned coupler ceramics possible ?
=> horizontal cleaning option ?
III. no cleaning agents; no polluting residues

❑ critical parameters of dry-ice cleaning

- spontaneous formation of snow-gas mixture by relaxation of liquid CO_2 (-78.9 C; ~ 50 bar)
- surrounding supersonic nitrogen gas
  => acceleration and focusing
  => partial avoidance of humidity condensation

❑ cleaning forces:

- thermo mechanical
  I. brittling by shock-freezing
  II. pressure + shearing forces by high momentum
  III. volume increase by sublimation
- chemo mechanical
  I. liquid CO_2 acts as solvent



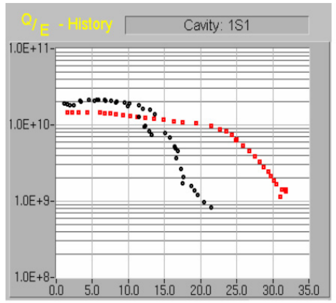
Explanation:
1: motor; **2**: IR-Heater; **3**: IR-Temp.sensor; **4**: nozzle system; **5**: horizontal nozzle; **6**: liqiufier:
7: Gases; **8**: motion control,Interlock,Temp.; **9**: exhaust of CO_2 and N_2

Cleaning parameters

CO_2-pressure:	~ 50 bar
N_2-pressure	12 – 18 bar
particle filtration	< 0,05 µm
environment of cleaning:	laminar flow class 10

Test results: 1 Cell Cavity

Q-values up to 4,0 $\cdot 10^{10}$ at 1.8 K => no surface contamination
gradients up to 33 MV/m => field emission is limiting effect



■ **Test result after first DIC process**

■ **Test result after improved DIC. Cavity stored under air for several months, no HPR before DIC**

Improvements

- Cavity is cleaned in horizontal direction -> in principle 9-cell cavities cleaning is possible.
- New purifier, more capacity
- Heating system with IR-heaters is installed. Fabrication of contured heaters with optimal wavelength is in progress
- Interlock-system (in progress) Control of Temperature,CO_2-Conc.,exhaust etc.

- Things to optimize in the future
  Heating of cavity
  Handling of cavity after DIC
  Optimal wavelength of heaters
  => heat-acceptance would be better
  => cover of cavity is not necessary
  more temperature sensors, to optimize the heating process