IEC62133 (2nd edition) Safety Test Standard of Li-Ion Cell and Battery

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Insulationandwiring

The insulation resistance between the positive terminal and externally exposed metal surfaces of the battery excluding electrical contact surfaces shall be not less than 5 MΩ at 500 V d.c.

Chargingmethods:

Method 1:

• Same as 1st edition method

•Applicable to all tests except external short circuit, thermal abuse, crush and forced internal short circuit tests

Method 2:

• Applicable to cells and batteries subjected to the external short circuit, thermal abuse, crush and forced internal short circuit tests.

• Condition cell/battery at either the upper or lower limit charge temperature of the cell operating region for 1-4 h

• CV Charge cell/battery at the upper limit charge voltage of the cell operating region until the charging current is reduced to 0.05 I_t A

Up limit charging voltage	Max. charging current	Charging temperature up limit	Charging temperature low limit
4.25 V/cell	Specified by cell mfg	45 ℃	10 ℃

8.2.1 Continuous charging at constant voltage (5 cells)

• Continuous CV charge per mfg specifications for 7 days

8.2.2 Moulded case stress at high ambient temperature (Moulded case battery)

Each fully charged battery is crushed between two flat surfaces. The force for the crushing is applied by a hydraulic ram exerting a force of 13 kN ±1 kN. The crushing is performed in a manner that will cause the most adverse result. Once the maximum force has been applied, or an abrupt voltage drop of one-third of the original voltage has been obtained, the force is released. A cylindrical or prismatic cell is crushed with its longitudinal axis parallel to the flat surfaces of the crushing apparatus. To test both wide and narrow sides of prismatic cells, a second set of cells is tested, rotated 90° around their longitude in a axes compared to the first set.

8.3.1 External short circuit (5 cells per temperature)

- Using charge method 2 to fully charge cell. Each cell is then short-circuited by connecting the positive and negative terminals with a total external resistance of 80 mΩ ±20 mΩ, The cells remain on test for 24 h or until the case temperature declines by 20 % of the maximum temperature rise, whichever is the sooner.
- Test at 20 ℃ ±5 ℃ only

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- Test at 55 ℃ ±5 ℃ only
- In case of rapid decline in short circuit current, the battery pack remains on test an additional hour after the current reaches a low end steady state condition (*e.g. battery with series connections voltage is below 0.8 V and decreasing < 0.1 V/ 30-minute period*)

8.3.3 Free fall (3 cells or 3 batteries)

- Each fully charged cell or battery is dropped three times from a height of 1,0 m on to a concrete floor .The cells or batteries are dropped so as to obtain impacts in random orientations.
- Cells/Batteries are examined 1 hour after dropping

8.3.4 Thermal abuse (5 cells)

Each fully charged cell by charging method 2 , stabilized at room temperature, is placed in a gravity or circulating air-convection oven. The oven temperature is raised at a rate of 5 ℃/min ± 2℃/min to a temperature of 130℃ ± 2 ℃. The cell remains at this temperature for 10 min before the test is discontinued.

Large cells (i.e. gross mass > 500 g) held at 130 C for 30 min.

8.3.5 Crush (5 cells)

Each fully charged cell by charging method 2, is crushed between two flat surfaces. The force for the crushing is applied by a hydraulic ram exerting a force of 13 kN ±1 kN. The crushing is performed in a manner that will cause the most adverse result. Once the maximum force has been applied, or an abrupt voltage drop of one-third of the original voltage has been obtained, the force is released. A cylindrical or prismatic cell is crushed with its longitudinal axis parallel to the flat surfaces of the crushing apparatus. To test both wide and narrow sides of prismatic cells, a second set of cells is tested, rotated 90° around their longitude in a axes compared to the first set.

Force can also be stopped when 10 % of deformation of initial dimension of cell has occurred (*or when* 13 kN ±1 kN *force is reached or abrupt drop of 1/3 original OCV, whichever is reached first*)

• Crush only wide side of prismatic cells

8.3.6 Over-charging of battery

- CC charge at 2.0 I_t A, using a supply voltage that does not exceed the max voltage supplied by the recommended charger or 5.0 V/cell if charger max voltage unknown
- Charging supply is sufficient to maintain 2.0 I_t A throughout the duration of test or until supply voltage is reached (switch to CV charge).
- TC placed on battery surface/pack casing. Charging continued until the temperature of the outer casing
- reaches steady state conditions *(less than 10 ℃ change in 30 minute period*) or returns to ambient

8.3.7 Forced discharge (5 cells)

A discharged cell is subjected to a reverse charge at 1 It A for 90 min.

8.3.8 Transport tests*

Tests not needed if UN transport documents are provided

8.3.9 Forced Short Circuit test:

A.5 Sample preparation

A.5.1 General

In order to provide more information regarding the sample preparation for test 8.3.9 the following additional details are provided.

A.5.2 Insertion procedure for nickel particle to generate internal short

The insertion procedure is carried out at 20 °C ± 5 °C and under -25 °C of DEW points.

A.5.3 Disassembly of charged cell

Remove winding core (assembled electrode/separator, roll, and coil) from the charged cell (See Figure A.5 and Figure A.8).

A.5.4 Shape of nickel particle

The shape of nickel particle shall be as shown in Figure A.2.

Dimensions: Height: 0,2 mm; Thickness: 0,1 mm; L shape (Angle: 90 ± 10°): 1,0 mm for each side with 5 % tolerance. Material: more than 99 %(mass fraction) pure nickel.

Dimensions in millimeters

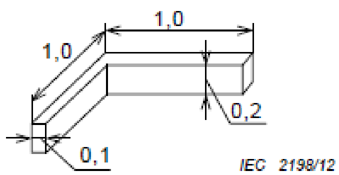

Figure A.2 – Shape of nickel particle

A.5.5 Insertion of nickel particle to cylindrical cell

A.5.5.1 Insertion of nickel particle to winding core

a) Insertion of nickel particle between positive (active material) coated area and negative (active material) coated area for cylindrical cell. (see Figure A.5)

   1) If outer turn of positive substrate is aluminum foil, cut off foil at the dividing line between aluminum foil and active material for active material to active material short test.

2) Insert nickel particle between positive active material and separator. The alignment of nickel particle shall be as shown in Figure A.3. Position of the insertion of nickel particle shall be at 20 mm from edge of the cut aluminum foil. Direction of L-shaped corner is towards the direction of winding.

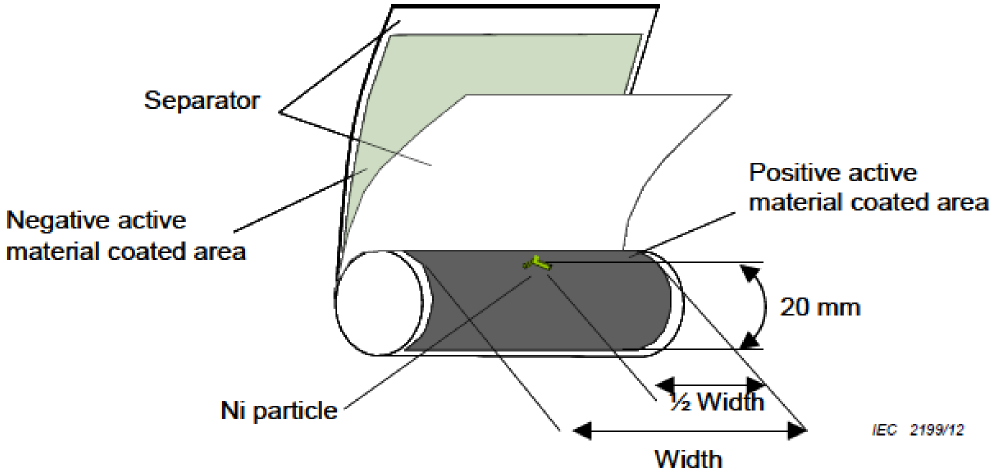

Figure A.3 – Nickel particle insertion position between positive and negative active material coated area of cylindrical cell

b) Insertion of nickel particle between positive aluminum foil (uncoated area) and negative (active material) coated area for cylindrical cell.

When aluminum foil of positive electrode is exposed at outer turn and the aluminum foil is facing the coated negative active material, following procedure shall be used.

1) When aluminum foil of positive electrode is exposed at outer turn, cut out the aluminum foil at 10 mm from the dividing line between aluminum foil and active material.

2) Insert Ni particle between aluminum foil and separator. The alignment of nickel particle shall be shown in Figure A.4.

Position of the insertion of nickel particle shall be at 1,0 mm from the edge of the coating of positive active material on aluminum foil.

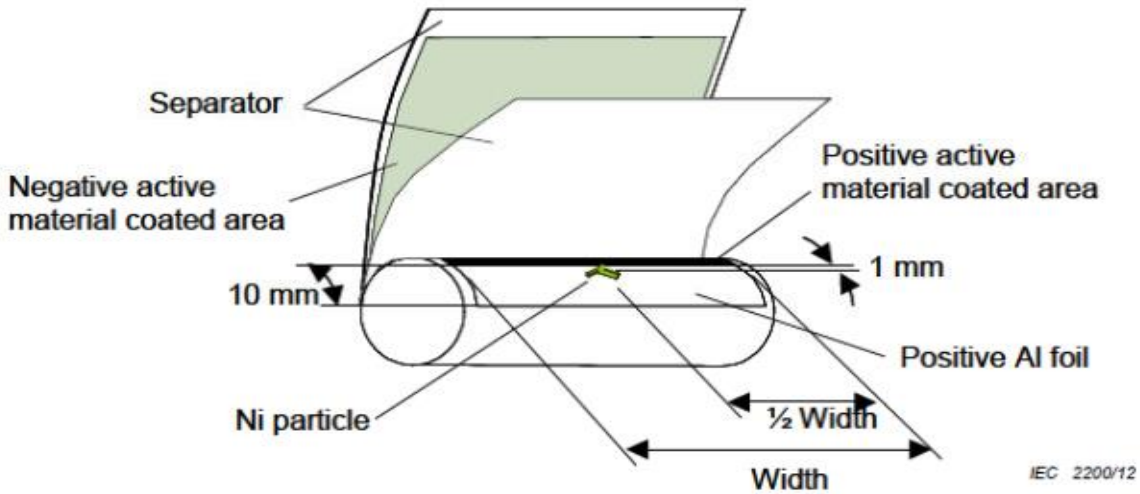

Figure A.4 – Nickel particle insertion position between positive aluminum foil and negative active material coated area of cylindrical cell


Positive tab
Negative tab
Extracted winding core
Cut
Cut
10 mm
Al foil and negative active material short circuit test
Place the Ni particle in the center
Ni particle
20 mm
Positive cut end
Insulating sheet
The Ni particle is under the separator
Mark the position of the Ni particle
Adhesive tape

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A.5.5.2 Mark the position of nickel particle on the both end of winding core of the separator

The procedure is as follows.

a) Place insulating sheet between the separator that is facing to nickel particle and the negative electrode to protect against short-circuits.

b) Manually roll back the electrodes and separator keeping the nickel particle in place and apply adhesive tape to the winding core.

c) Mark position of the nickel particle across the winding core.

d) Put winding core in a polyethylene bag with sealing zipper and seal it. Put the polyethylene bag into aluminum-laminated bag to prevent from drying out.

   Remark: Procedure shall be completed within 30 min.

A.5.6 Insertion of nickel particle to prismatic cell

a) Prior to inserting nickel particle, insert an insulating sheet between the negative electrode and the separator that is below nickel particle and the negative electrode, as shown in Figure A.6, to protect against short-circuit.

b) Insertion of nickel particle to winding core

   1) Insertion of nickel particle between positive (active material) coated area and negative (active material) coated area for prismatic cell. (see Figure A.8)

      i) Insert nickel particle between positive (active material) coated area and separator or between separator and negative (active material) coated area. In case of aluminum cell enclosure, insert nickel particle between positive (active material) coated area and separator.

      ii) Insert nickel particle between positive active material and separator. The alignment of nickel particle shall be shown in Figure A.6. Nickel particle is set at the center (diagonally) of the winding core. Direction of nickel particle L-shape corner is towards the direction of winding.

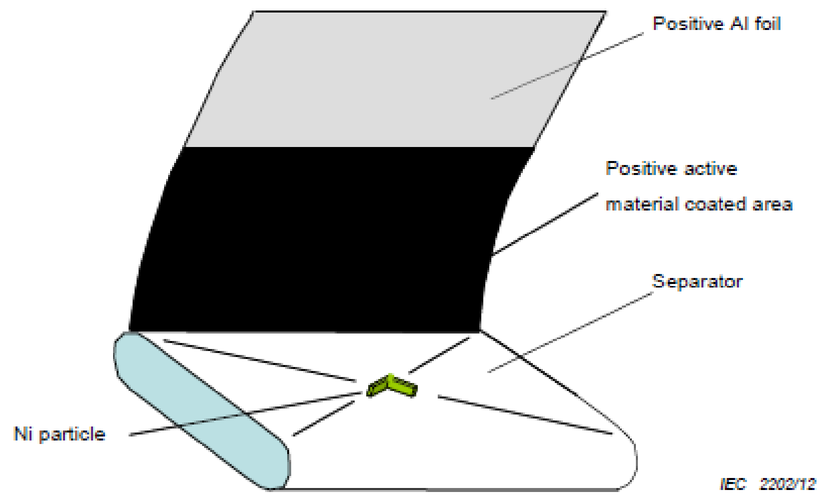

Figure A.6 – Nickel particle insertion position between positive and negative (active material) coated area of prismatic cell

2) Insertion of nickel particle between positive aluminum foil (uncoated area) and negative (active material) coated area for prismatic cell. When aluminum foil of positive

electrode is exposed at outer turn and the aluminum foil is faced to coated negative active material, the following test shall be performed:

i) The aluminum foil of positive electrode is exposed at outer turn and the aluminum foil is faced to coated negative active material, insert nickel particle between aluminum foil and separator;

ii) The alignment of nickel particle shall be shown in Figure A.7. Nickel particle is set at the centre of flat winding core surface. Direction of nickel particle L - shape corner is towards the direction of winding.

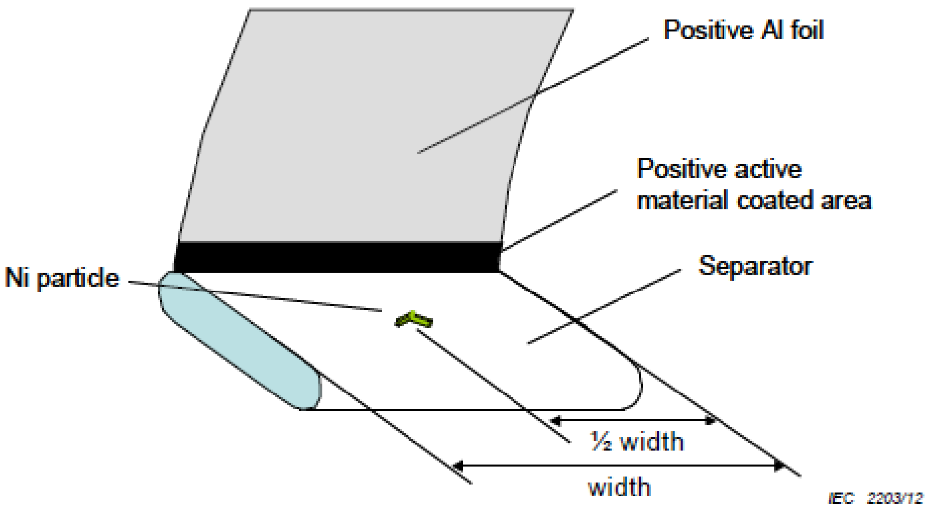

Figure A.7 – Nickel particle insertion position between positive aluminum foil and negative (active material) coated area of prismatic cell

iii) Manually roll back the electrodes and separator keeping the nickel particle in place and adhesive tape the winding core.

iv) Mark the position of nickel particle across the winding core.

v) Put two layers of polyimide tape (10 mm width, 25 μm thickness) at the marking position.

vi) Put winding core into a polyethylene bag with sealing zipper and seal it. Put the polyethylene bag into aluminum-laminated bag to prevent from drying.

Remark: Procedure should be completed within 30 min.

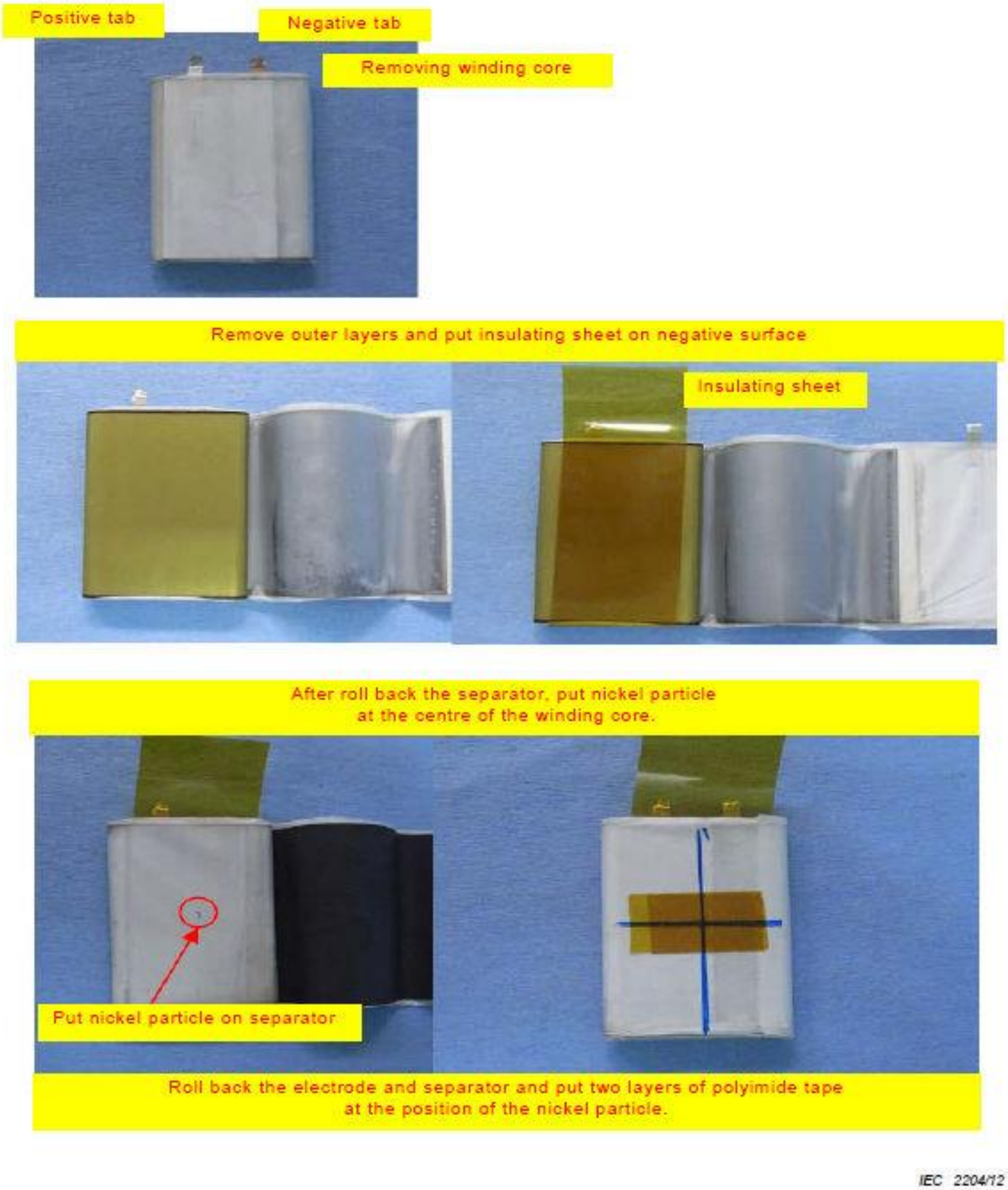

Figure A.8 – Disassembly of prismatic cells

Press machine requirements:

3) Pressing the winding core with nickel particle

Temperature-controlled oven and special press equipment are needed for the test.

Moving part of the press equipment shall move at constant speed and can be stopped immediately when short-circuit is detected.

i) Preparation for the test

A The temperature of the oven is controlled as specified in Table 5. Samples preparation guidance is provided in Annex A, Clause A.5 and in Figure A.5 and Figure A.8. Put aluminum-laminated bag with winding core and nickel particle into the oven for 45 ± 15 min.

B Remove the winding core from sealed package and attach terminals for voltage measurement and thermo couple for temperature on the surface of the winding core. Set the winding core under the pressure equipment to locating the point of the place of the nickel particle under the pressing jig.

Remark: To prevent evaporation of electrolyte, finish the work within 10 min from removing the winding core from the oven for temperature conditioning to closing the oven door where the equipment is located.

C Remove insulating sheet and close the oven door.

ii) Internal short circuit

A Confirm that the winding core surface temperature is as defined in Table 5 and then starts the test.

B Bottom surface of moving part of the press equipment is made of Nitrile rubber or Acryl, which is put on the 10 mm x 10 mm stainless steel shaft. The detail of pressing jigs shall be shown in Figure 2. Nitrile rubber bottom surface is for cylindrical cell test. For prismatic test 5 mm x 5 mm (2 mm thickness) Acryl is put on the Nitrile rubber. The fixture is moved down at the speed of 0,1 mm/s monitoring the cell voltage. When voltage drop caused by the internal short-circuit is detected, stop descent immediately and keep pressing jig in the position for 30 s and then release the pressure. Voltage is monitored more than 100 times per second and if voltage is dropped more than 50 mV compare to the initial voltage, it is defined to internal short circuit has occurred. If the pressure reaches 800 N for cylindrical cell and 400 N for prismatic cell, stop descent immediately and then keep in the position.

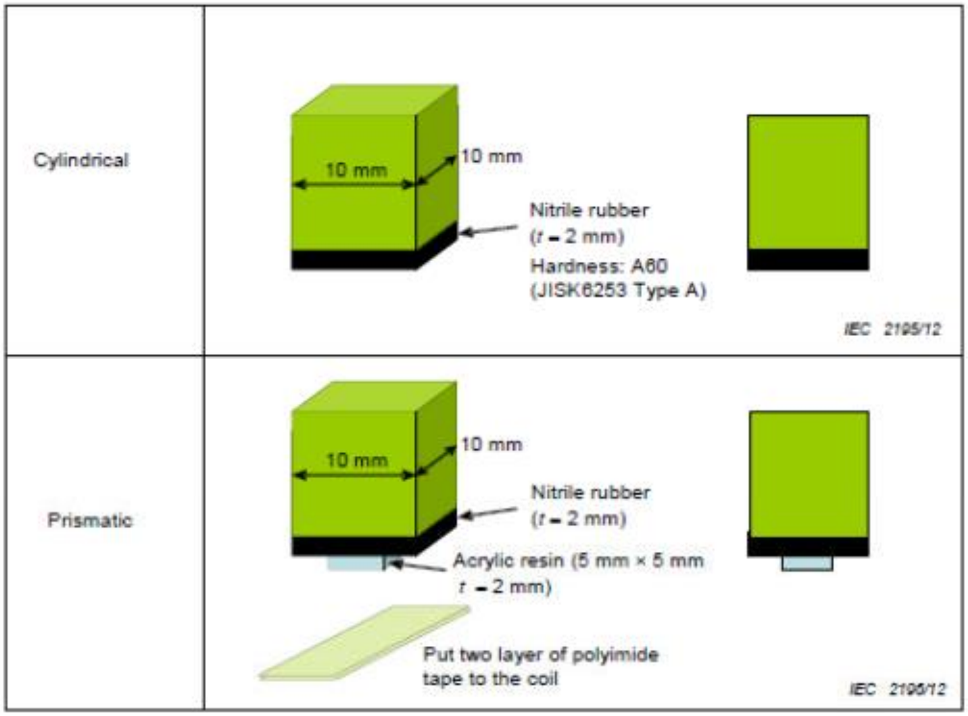

Figure 2 – Jig for pressing

c) Acceptance criteria

No fire. (Record the pressure when short-circuit occurred if there was no fire.)