Peltier Cooled Cloud Chamber E-114

Operation Manual

Rado Co., Ltd

20230531E114 IAEA

RADO Peltier Cooled Cloud Chamber E-114

Rado Co., Ltd.

1. Specification

- RADO Peltier Cooled Chamber E-114 is a cloud chamber that uses Peltier element for cooling to observe the radiation tracks.
- A wide observation surface with a diameter of 75 mm allows the observation of multiple tracks. 5 to 6 observers may view the phenomenon simultaneously.
- Tracks begin to appear within several minutes after turning on the power.
- It is possible to add ethanol from the bottle with one push without interrupting the observation.
- Since the observation layer is illuminated with twelve super bright LEDs, the tracks clearly appear in room light and darkroom is unnecessary.
- Since excessive ions are removed by applying higher voltage to the observation surface, fine tracks such as beta rays can also be observed.
- Because the kit is fully outfitted the observation may be commenced immediately without complicated assembly and wiring.
- As source samples, a mantle for supplying ^{220}Rn and a ceramic monazite ball are attached.
- Since it has low power consumption, it is possible to run multiple units simultaneously.
- The kit is set at an optimum condition for track observation, and no adjustment is required.

2. The Equipment components and accessories

① Cloud Chamber Body

② Power supply unit

③ Bottle for Radon gas injection

④ Bottle for alcohol injection

⑤ Observation window

⑥ Protective lid

⑦ AC/DCadapter

⑧ Conversion plug

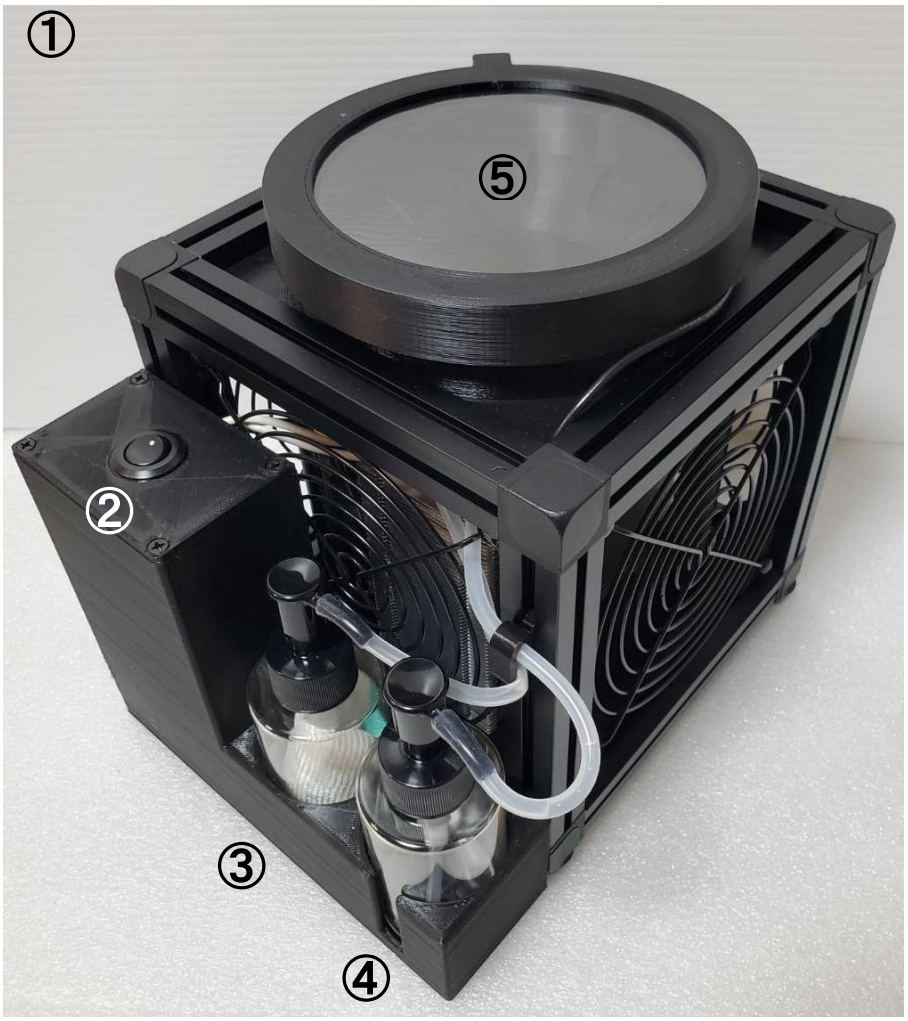
⑨ Tweezers

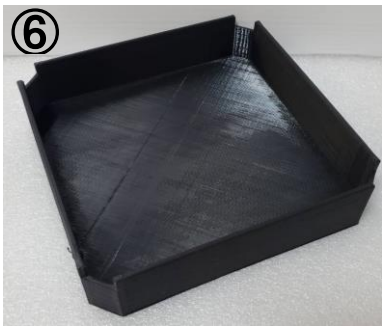
⑩ Monazite ball

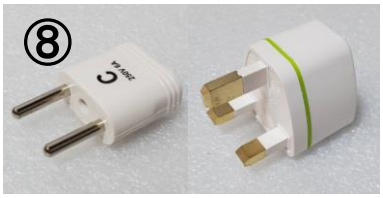
⑪ Filter stand

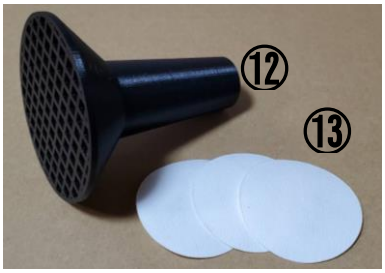
⑫ Filter attachment

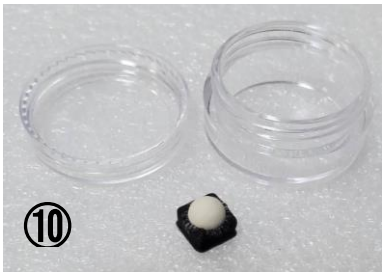
⑬ Dust sampling filter (3 sheets)











3. Consumables required for experiments

⑭ Ethyl alcohol (99.5 percent or more pure)

4. Preparation ～ Observation of natural radiation tracks

1) Remove the lid of the alcohol bottle.
2) Add about 100ml of ethanol (purity: 99.5% or more) into the alcohol injection bottle.
3) Close the lid of the alcohol bottle.
4) Check that the switch is turned off.

5) Insert the cable plug into the power supply socket.
6) Supply alcohol into the cloud chamber by gently pushing the alcohol injection bottle about 10 times.
7) Turn on the main power supply switch.
8) LED will light up and cooling will begin.

9) After several minutes (about 5–10 minutes) the natural radiation tracks will appear.
10) There are several kinds of natural radiation tracks. Mainly they are entangled short tracks of beta rays and alpha rays, but very rarely long cosmic rays may be observed.
11) However, if you're doing the experiment in a room with little natural radiation, you won't see too many natural radiation tracks.
12) Also, when conducting experiments in a hot room, it is difficult to observe natural radiation tracks because the cloud chamber cannot be cooled. In that case, proceed to Radon gas experiment.

A track of natural radiation

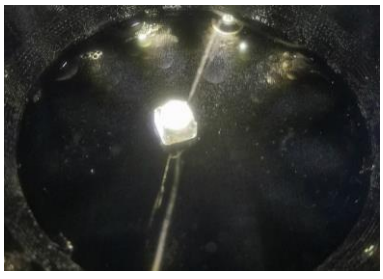
13) The initial supply of alcohol will vaporize within about 10 minutes depending on the surrounding temperature. Push the alcohol injection bottle once or twice to replenish the alcohol when the tracks disappear.
14) When the observation window becomes dim, wipe gently with a soft tissue so that it will not scar the surface.

5. Radon gas (Observation of alpha ray tracks from Radon gas)

1) While observing natural radiation, push the radon gas injection bottle about 10 times slowly and supply Radon gas to the cloud chamber.
2) Shooting of the thick and short alpha ray tracks all around like fireworks will be observed.
3) Since this radon has a short half-life of 55.6 seconds, it will become almost invisible within several minutes, and the state in which only natural radiation can be observed will gradually return.
4) This shows the short half-life (0.145 seconds) of the radioactive decay series when radon (Rn) from the thorium (Th) series alpha-decays to lead (Pb) via polonium (Po). (It appears that two α-decays, Rn to Po and Po to Pb, occur simultaneously.) Below is part of the decay series.

	(α-decay)		(α-decay)		(α-decay)	
^{224}Ra	→	^{220}Rn	→	^{216}Po	→	^{212}Pb
(Half-life)		(Half-life)		(Half-life)		(Half-life)
3.66 days		55.6seconds		0.145 seconds		10.64 hours

6. Monazite ball (Observation of alpha ray tracks from Monazite ball)



1) Switch off and open the lid of the cloud chamber.
2) If the observation plate is moist from accumulated alcohol, gently wipe it off.
3) Place the monazite ball on the observation plate of the cloud chamber with the white ball on the upper side.
4) Close the lid of the cloud chamber.
5) Supply alcohol to the cloud chamber and turn on the switch.
6) Alpha rays emitted from the monazite ball will appear. Looking closely the tracks of beta rays may also be observed.

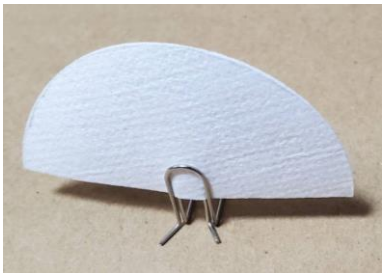
7） Since alphas ray have weak penetration power, they will gradually disappear when they become shielded by alcohol moisturizing the surface of the monazite ball.

7. Dust sampling filter (Observation of alpha ray tracks from radioactive material in air adsorbed by filter)

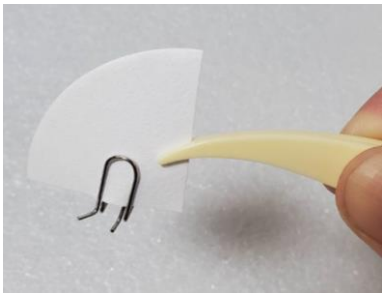
1） Set the filter by inserting the filter installer into the suction port of the vacuum cleaner.

2） In a poorly ventilated room (bare concrete room is preferable), operate the vacuum cleaner for about 1 hour and let the filter adsorb the radioactive substance in the air.

3） Cut the filter in half or quarter and set it on the filter stand.. At this phase use tweezers etc. to handle the filter. Do not touch the filter directly with bare hands to avoid the radioactive substance from peeling off.



4） Place the filter in the cloud chamber and start observation in the same manner as observing the tracks from the monazite ball.



5） Alpha rays coming out from the adsorption surface of the filter will be observed.

6） As the filter gets moist with alcohol, it will gradually disable the observation of the tracks.

7） Depending on the type and amount of radioactive substances adsorbed on the filter, the radioactivity as a source of observation of the filter will be lost within several hours.

8. Cleaning up after use

1） When observation is completed, switch off, disconnect the power cable.

2） Open the lid in a well-ventilated place and remove the radiation source that was placed in the cloud chamber.

3） Gently wipe off the alcohol on the bottom surface of the observation plate with soft tissue.

4） Let the inside of the cloud chamber and the inside of the observation window dry for about 1 hour, then close the lid.

5） Cover the observation window with the protection lid before storing the kit away.

9. Operational considerations

1） Use anhydrous ethanol with a purity of 99.5% or more. (If the purity is low, moisture freezes inside the cloud chamber and frost forms or tracks become difficult to see.)

2） It is possible to observe the tracks by placing another radiation source. However, large source will make the observation difficult because it prevents the cooling of the bottom surface of the observation plate.

3） When adding alcohol to the bottle, care should be taken not to apply excessive force to the connected tube.

4） If the alcohol accumulates in the bottom surface of the observation plate gently wipe it off with soft tissue after turning off the kit.

5） Depending on the air temperature, the power supply adapter may become warm, but it is not abnormal.

10. **Warning** (Incorrect handling may lead to **serious consequences such as death or illness.)**

1) Always keep the room well ventilated to prevent vaporized alcohol from the cloud chamber to remain in the air.

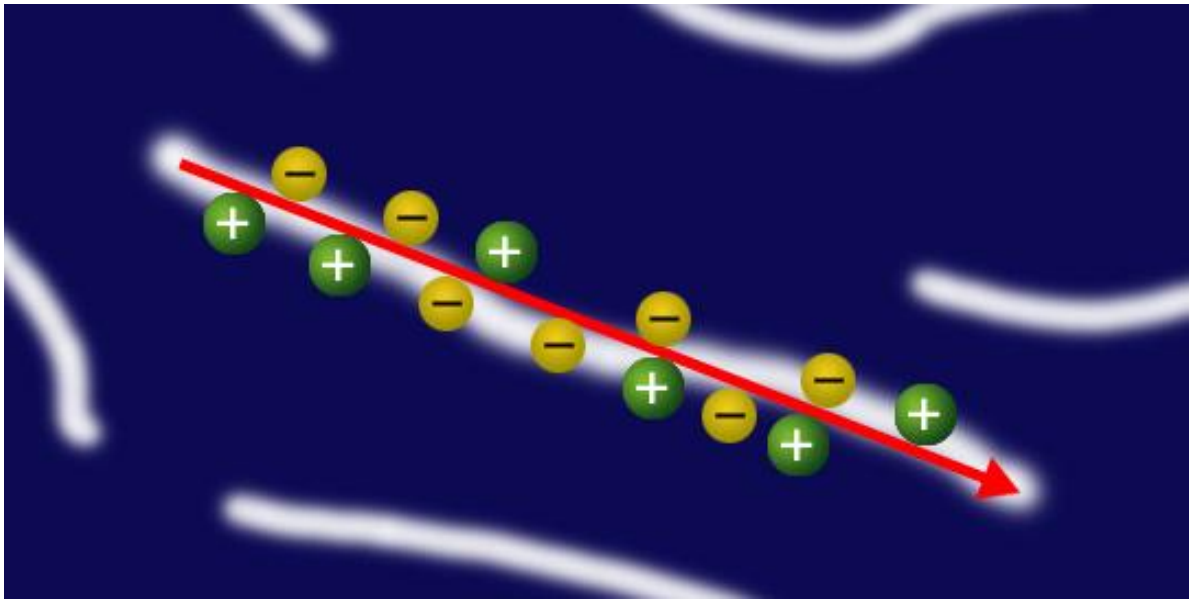
2) At all times turn off the switch when opening of the cloud chamber for wiping off the alcohol accumulated in the bottom surface of the observation plate or putting the radiation source inside the cloud chamber and all other purposes.

11. **Reference** (Reason why the tracks are visible)

The cloud chamber is saturated with evaporated alcohol.

The upper part of the cloud chamber is saturated at a temperature close to room temperature (20° C). However, because the lower part is cooled to about −35° C the alcohol vapor is unstable and over-saturated. Under such condition the alcohol molecules try to bond together. A sharp temperature gradient of approximately 50° C to 60° C between the top and bottom of

the cloud chamber causes supersaturation of alcohol.



When radiation passes through this over-saturated container, electrons of nitrogen, oxygen, and other gas molecules along its path are bounced off and ions are formed along the path. With these ions as nuclei, alcohol molecules condense to form droplets, forming an alcohol cloud.

What is observed as radiation tracks when light is shone on the cloud is this path.

The reason for darkening the surroundings and illuminating the bottom of the glass container with a strong light source from the sides of the container is because tracks appear near the bottom where the over-saturated layer is formed.

Further, in order to condense alcohol molecules only on the ions in the path of the radiation, the glass container must be cleared of any ions that are in the way. Therefore, in this device, voltage is always applied inside the cloud chamber.

12. Contact Us

For any unclear point about handling and experimental methods, please contact us. Rado Co., Ltd. (mail: t-toda@kiribako-rado.co.jp)

Please refer to the latest manuals and videos here.

https://kiribako-rado.co.jp/manual/