

Ionization of air through radioactivity

Objects of the experiments

- Ionization of air through radioactivity between two electrodes to which a voltage is applied.
- Detecting the charge transport between the electrodes.

Principles

Apart from a few ions, which are produced, e.g., by cosmic radiation, air consists of neutral molecules. Therefore it acts as an insulator. Between two electrodes to which a voltage is applied, no charge transport will occur as long as the applied voltage is below the voltage required for spontaneous discharge through impact ionization.

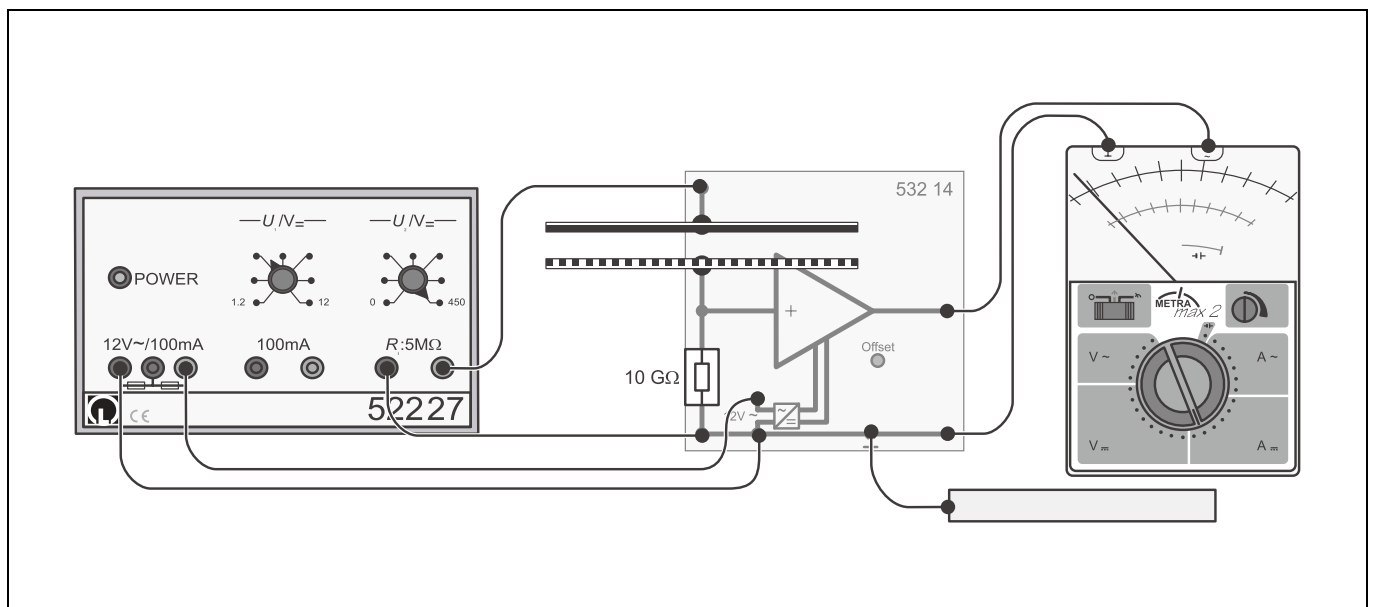
When H. Becquerel discovered radioactivity on uranium salts in 1895, he observed that air is ionized through radioactivity and that radioactivity can be identified by means of this ionizing power. The produced ions make possible a charge transport between two electrodes, which can be detected by means of a sensitive amperemeter even if the voltage between the electrodes is not sufficient for spontaneous discharge to take place.

Setup

The experimental setup is illustrated in Fig. 1.

- Connect the electrometer amplifier to the 12 V output of the power supply 450 V.
- Equip the input of the electrometer amplifier with the pair of electrodes and the 10 GΩ resistor, and connect it to the 450 V output of the power supply 450 V.
- Connect the output of the electrometer amplifier to the voltmeter.
- Connect the connection rod to the ground of the electrometer amplifier.

Fig. 1 Experimental setup for detecting the ionization of air through radioactivity.



Apparatus

1 Am-241 preparation, 330 kBq	559 82
1 electrometer amplifier	532 14
1 zinc plate for photoelectric effect	546 31
1 grid electrode	546 33
1 connection rod	532 16
1 STE resistor 10 G Ω , 0.5 W	577 03
1 voltmeter, U \leq 10 V- e.g.	531 100
1 power supply 450 V-	522 27
connection leads	

Carrying out the experiment

- Apply 450 V to the two plates, and keep the connection rod in your hand.
- Read the output voltage U of the electrometer amplifier and take the current $I = \frac{U}{10 \text{ G}\Omega}$ down.
- Hold the Am-241 preparation between the plates (see Fig. 2), and read the current I again.

Measuring example

Voltage between plates: $U_p = 450 \text{ V}$

without preparation: $I = 0$

with preparation: $I > \frac{10 \text{ V}}{10 \text{ G}\Omega} = 1 \text{ nA}$

Evaluation and results

Molecules of the air are ionized by the radioactive radiation (α radiation) from the Am-241 preparation. Therefore charge carriers are available between the two plates to which a voltage is applied so that a small current can flow which is clearly measurable by means of the electrometer amplifier.

Safety notes

When radioactive preparations are handled, country specific regulations must be observed such as the Radiation Protection Regulation (StrSchV) in Germany. The radioactive substances used in this experiment are approved for teaching purposes at schools in accordance with the StrSchV. Since they produce ionizing radiation, the following safety rules must nevertheless be kept to:

- Prevent access to the preparation by unauthorized persons.
- Before using the preparation make sure that it is intact.
- For the purpose of *shielding*, keep the preparation in its safety container.
- To ensure *minimum exposure time* and *minimum activity*, take the preparation out of the safety container only as long as is necessary for carrying out the experiment.
- To ensure *maximum distance*, hold the preparation only at the upper end of the metal holder and keep it away from your body as far as possible.

Fig. 2 Ionization of air through radioactivity between two plates.

