

## MODULE:

Chemistry in computing: Piezoelectric materials

## DESCRIPTION OF EXERCISE:

Piezoelectric materials are materials that generate an electrical charge on a surface resulting from an applied mechanical force. The phenomenon is called *direct piezoelectric effect*. There is also the *converse piezoelectric effect*, where material is mechanically deformed as a result of an applied electrical field. In general, this implies the ability of a material to change mechanical energy into electricity and vice versa (Figure 1).

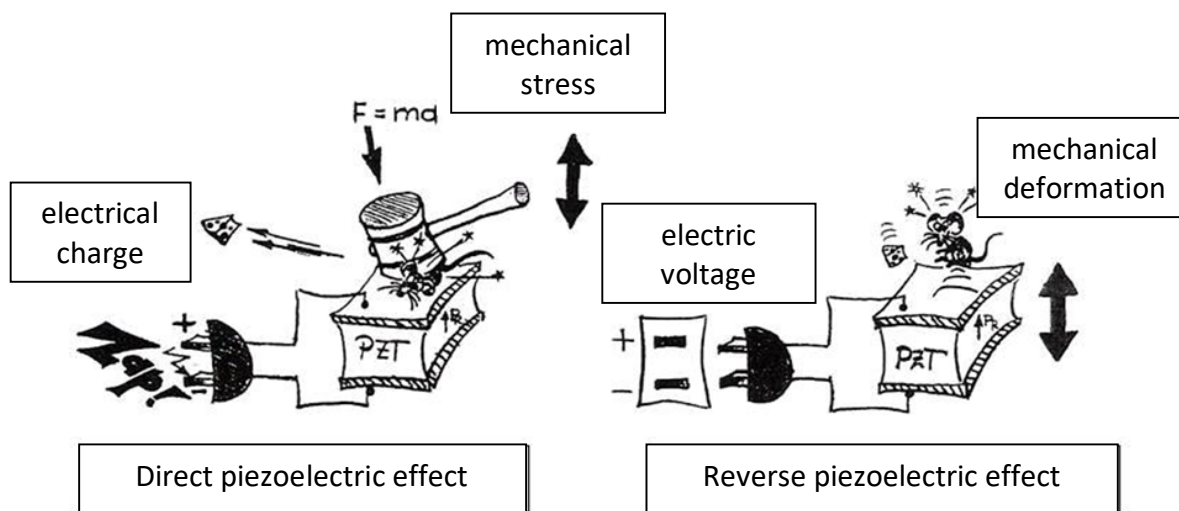


Figure 1 Display of direct and reverse piezoelectric effect

The easiest example of a piezoelectric effect is a lighter. By pressing a button, one presses a spring, thus applying mechanical stress to a piezoelectric crystal found below the spring. As a result of mechanical stress, an electric charge (electric current) is formed that generates a spark, which ignites the gas.

Piezoelectric materials play an important role in a number of everyday applications and, although we may not realise it, the piezoelectric effect is used at least 10 times a day. In the morning, one is woken up by the piezo buzzer from an alarm clock. Fuel efficiency in our cars is improved with piezoelectric injectors, airbags are controlled with a piezoelectric accelerometer, and ultrasound parking sensors prevent us from colliding.

Microscopes and precise machines use very accurate piezoelectric motors and sensors, while ultrasonic cleaning baths with piezo transducers clean work pieces and tools at factories. The piezoelectric effect is also present in inkjet printers and our cell phones, as camera pictures are enhanced using a piezo motor.

Hospitals use ultrasonic transducers (ultrasound diagnostics) to look into our body, and piezoelectric motors are used in magnetic resonance imaging.

The most important piezoelectric materials are quartz, piezoelectric polymers, and piezoelectric ceramics. Due to excellent characteristics, piezoelectric ceramics based on lead zirconate titanate –  $\text{Pb}(\text{Zr}_{1-x}\text{Ti}_x)\text{O}_3$  (PZT) – are technologically the most important and widespread. Since lead is toxic for people and the environment, many research studies have

recently focused on eliminating or at least reducing the use of PZT and on searching a suitable replacement for that material.

Additional literature:

J. Holterman, P. Groen, An Introduction to Piezoelectric Materials and Applications. Apeldoorn, The Netherlands: Stichting Applied Piezo, 2013.

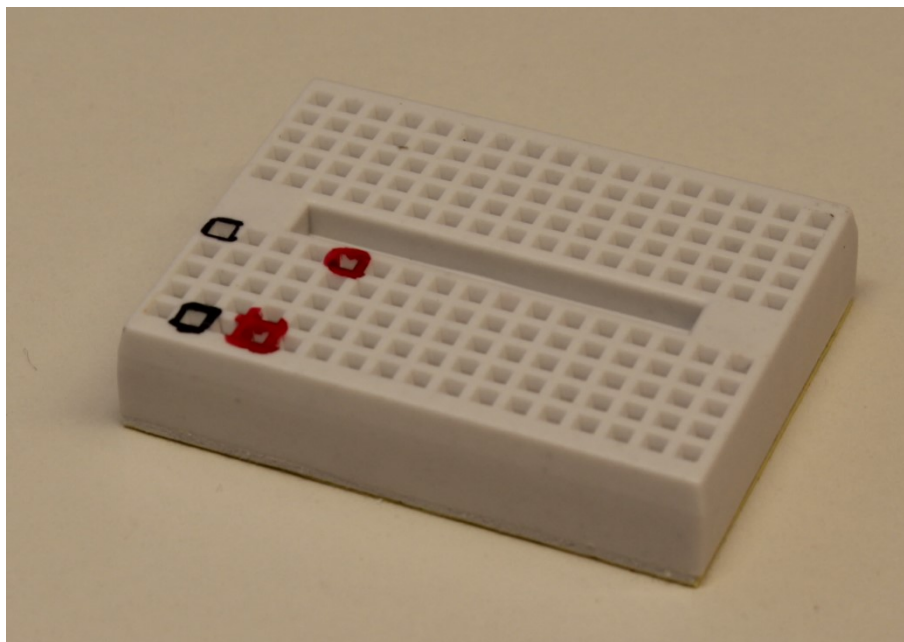
### **MATERIAL:**

- piezoelectric buzzer
- LED light
- AC/DC converter
- test plate

### **METHODS OF WORK:**

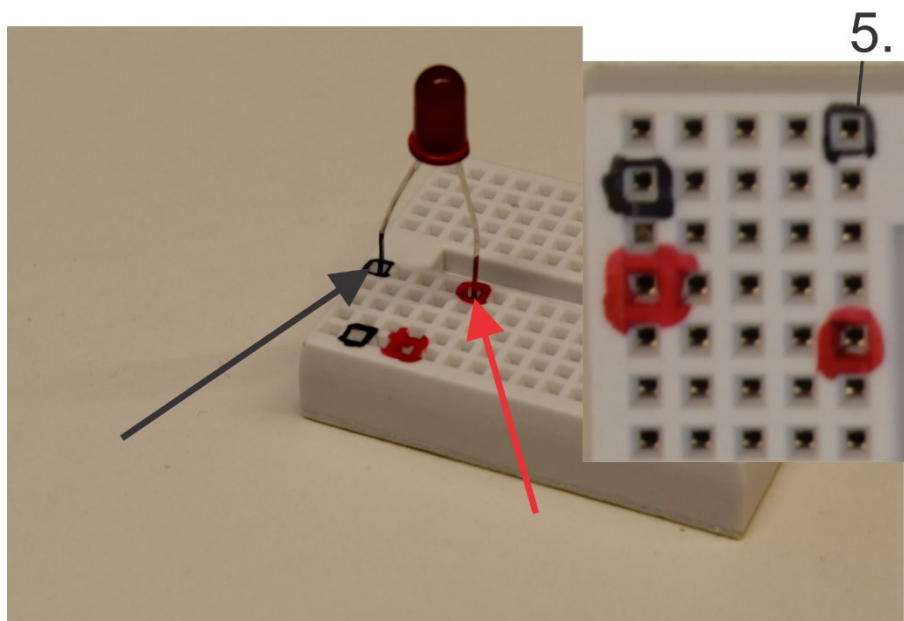
Step 1.

Take a test plate.



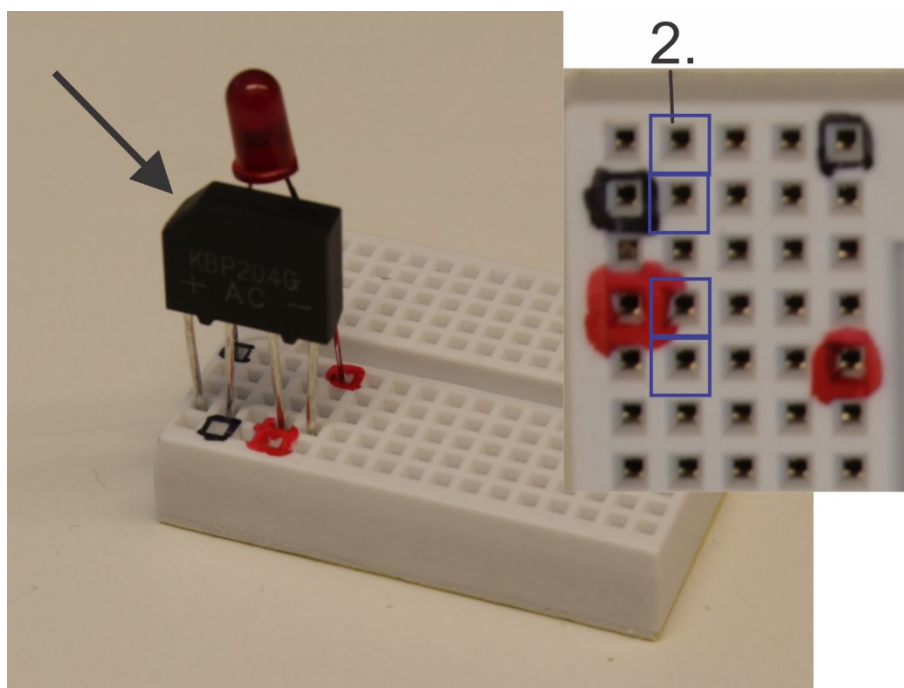
### Step 2.

Clamp the LED light in the 5<sup>th</sup> row of the test plate, i.e. in the red and black hole, so that the colours on the light match the colours on the plate (black to black, red to red).



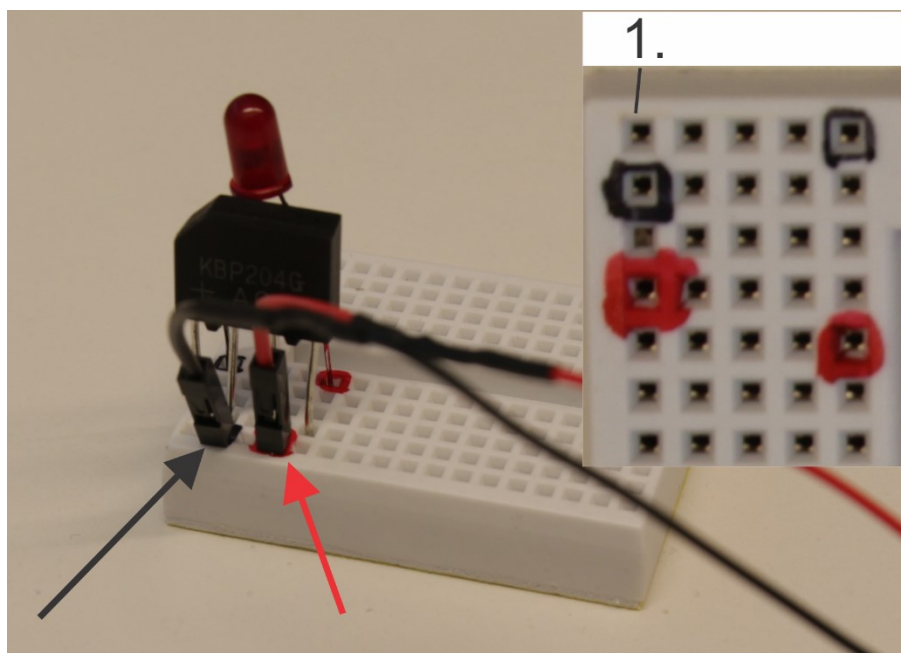
### Step 3.

Clamp the AC converter in the 2<sup>nd</sup> row of the test plate, i.e. in the holes marked with blue squares in the picture. Importantly, the marked top (see the black arrow) must be on the left side of the plate.



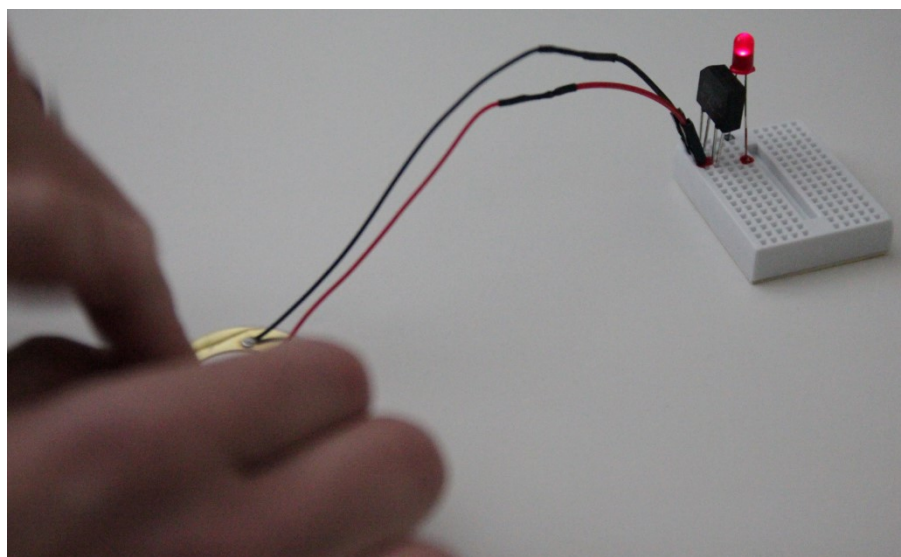
#### Step 4.

Clamp the piezo buzzer in the 1<sup>st</sup> row of the test plate, so that wire colours match the colours on the plate.



#### Step 5.

When pressing the white part of the piezo buzzer, the LED light will glow.



## RESULTS:

Observe the experiment and describe what happens and why.

## REPORT:

Prepare a report on the presence of piezoelectric materials in everyday environment.

## TEST:

What is the name of an electronic component storing an electric charge or electricity?

What type of ceramics did our ancestors know how to use 20,000 years B.C.?

What material enables the conversion of electricity into mechanical energy and vice versa?

What is the name of the process of firing ceramics in which material becomes thicker, harder and more compact?

What is name of the structure with periodically arranged atoms in solid state?

## EVALUATION OF THE PRACTICAL:

Knowledge for practical:			
Experimental exercise:			
Results and answers:			
Compliance with security rules:			
Review date:		Supervisor signature:	