Capacitive sensor for counting and measuring nanodroplets

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The spread of airborne diseases in crowded places is a global issue, even more so during pandemic times. Sick individuals introduce virus-containing nano- and micro-size aerosols into the air, which can infect healthy people. Since dedicated instrument to detect nanoparticles in the air are expansive and non-portable, hospitals and care institutions are without proper monitoring tools and can only rely on the assurance of the air condition service that the indoor air is clean and without pathogens.

With the aim to address this problem, we develop a miniaturised low-cost detector (Figure 2, left) for detecting of nanodroplets in air, which can be also used in other applications, such as testing of inhalers-dosed drugs (medical/pharmacy), analysing of droplets in clouds (meteorology) and spray mist (agriculture), and for monitoring of air pollution with particles (air quality).

Our miniaturized sensor is based on the detection of time-dependent capacitance (Iskra, 2010). The measurable change of the capacitance is caused by the impact of a nanodroplet or nanoparticle covered with condensed water into a water layer situated between both electrodes of the sensor (Figure 1). The impact of the nanoparticle causes a crater in the water, which causes a change in the capacitance.

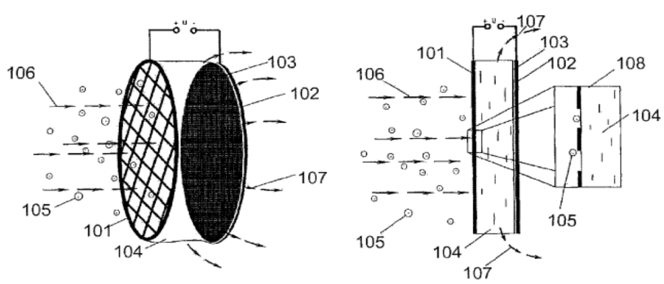

Figure 1. Principle of particle detection by capacitive method (Remskar, 2015).

The sensor (Figure 2, right) consists of a multilayer printed circuit board (PCB). The bottom layer of the PCB is used only to reinforce the sensor. On the other hand, the top layer has several functions. The copper on this layer is patterned to form one of the electrodes of the capacitor. The dielectric core of the capacitor with a high dielectric constant is used as the dielectric isolation layer of the sensor. The top copper is shaped in a form of rays and support the second electrode, which is perforated. The used technology enables a simple, low-cost and reliable production process that can be up-scaled.

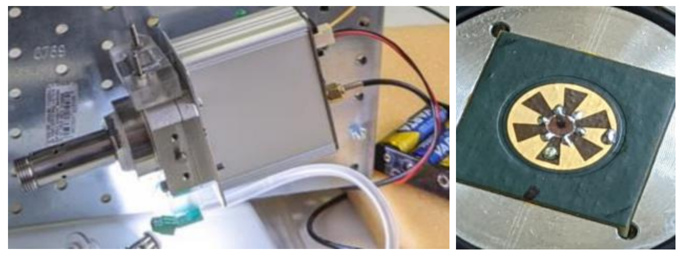

Figure 2. The prototype of the detector (left) and sensor (right).

The capacitance change is converted into an electrical signal (Figure 3, left) by a preamplifier. When the nanodroplet hits the sensor, an electric pulse (Figure 3, right), which magnitude depends on the size of the impacted nanodroplet, is generated. This enables for a continuously measuring of the number concentration of the nanodroplets in the analysed air.

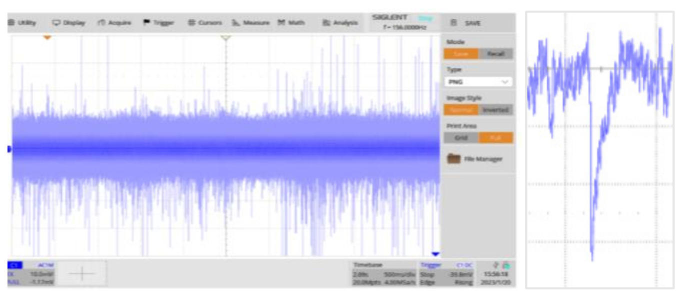

Figure 3. Detected signals under impact of water droplets (left) and signal shape (right).

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