

RESPIRATION — Clean Air Through Sound: Acoustic Cleaning of Fine Particles

Fine particles smaller than 2.5 micrometers (PM2.5) are so small they are invisible to the naked eye, but they penetrate deep into the lungs. They cause serious diseases — asthma, heart disease, and lung cancer. In many European cities, the concentration of these particles exceeds WHO recommended limits by 2 to 3 times.

Pharmaceutical factories, computer chip manufacturing, and hospitals require almost "sterile" air free from these particles. Traditional filters work poorly, require constant replacement, and consume a lot of energy.

The RESPIRATION project developed a new approach: using sound to clump fine particles into larger clusters before they reach the filter. Here is how it works: special metal plates inside the ventilation system emit sound at a specific frequency. When air with particles passes by them, the sound affects the particles — they "stick" to each other, forming larger clusters. Larger clusters are much easier to catch with an ordinary filter.

An experiment in the PIAP laboratory in Warsaw showed impressive results: sound plates collect fine particles 6.8 times more effectively than without sound. At the same time, they use 40 percent less energy to pump air. This means filters last longer and energy costs are lower.

Based on these results, three practical variants were developed: the AIRSONIC module for clean rooms in pharmaceutical factories and electronics manufacturing, with the benefit that filters last 1.5 to 2 times longer and energy consumption is reduced by 20 to 25 percent. Sonic Lock is an autonomous system for any ventilation system. A portable module weighing 8.2 kilograms for mobile robotic platforms is useful for emergency situations when quick air purification is needed.

Practical benefits of the technology for human health: cleaner air means fewer respiratory diseases, especially for hospital and manufacturing workers. For the environment: less energy is spent on ventilation, which helps in fighting climate change. For the economy: significant savings on filter replacement and electricity.

Results have been published in international scientific journals, presented to experts in the pharmaceutical, energy, and robotics industries. The project became a finalist in the Sikorsky Challenge 2025 innovation competition. A patent application has been filed. For more information: <https://piap.lukasiewicz.gov.pl/badanie/projekt-respiration/>