

Streszczenie w języku angielskim

The motivation for developing the proposed air filter inserts stems from the persistent and unresolved problem of air pollution. The deterioration of air quality represents a phenomenon that poses a direct threat to human life. The outcome of the project enhances existing air filtration solutions. Ventilation, air conditioning systems, and portable air purifiers play a crucial role in maintaining clean indoor air. To achieve the required standards, it is often necessary to employ complex, multi-stage systems consisting of a pre-filter, a HEPA filter, and an activated carbon filter. In addition, air conditioning systems may also serve as potential substrates for the growth of harmful molds and bacteria, which constitute a serious health risk. The main strategies for eliminating or preventing microbial growth in air conditioning systems are based on frequent cleaning, the use of antibacterial coatings, or the integration of UV lamps. However, such systems are associated with high costs. The proposed approach allows for the replacement of two filters – for example, an activated carbon filter and an ion filter - with a single type of filter. Moreover, unlike UV lamps, photocatalysts, plasma, or ozone-based systems, the proposed solution does not require a separate power source; the adsorbents are universal and can be applied in different types of filters. This will significantly reduce the cost of filtration systems and portable air purifiers. The adsorptive layer will also exhibit an extended service life due to the possibility of regeneration through thermal desorption. The invention is based on natural and safe materials such as vermiculite, a mineral that has no harmful environmental impact, and chitosan, which is non-toxic and biodegradable. The synthesis of the adsorbents involves a simple, environmentally friendly method.

The dissertation includes a literature review on air pollutants, purification methods, and applied adsorbents. The experimental section presents the acid modification of vermiculite, the synthesis and characterization of hybrid materials containing zinc and silver, as well as the evaluation of their adsorption properties toward volatile organic compounds (VOCs) and carbon dioxide. The obtained materials were analyzed in terms of pollutant removal efficiency under conditions approximating real environments, regeneration capacity, and antibacterial and antifungal activity. The results confirm the high effectiveness of the developed adsorbents, combining VOCs capture capability with antimicrobial performance. These materials therefore represent a promising alternative to conventional air filtration systems, characterized by greater durability, reduced environmental impact, and lower production costs.