ИННОВАЦИОННЫЕ ЭКОЛОГИЧЕСКИ БЕЗОПАСНЫЕ АКУСТИЧЕСКИЕ МАТЕРИАЛЫ ДЛЯ ЗАЩИТЫ ОТ ШУМА В МАШИНОСТРОЕНИИ И СТРОИТЕЛЬСТВЕ (ОБЗОР)

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Цель работы — анализ наиболее актуальных направлений в области создания шумопонижающих композиционных материалов, используемых в машиностроении и строительной отрасли.

Общемировые тенденции свидетельствуют о том, что эффективные инновационные материалы для снижения структурной вибрации и шума могут быть созданы на основе компонентов с высоким показателем механических потерь в широком диапазоне температур и частот. К таким веществам относятся натуральные волокна (НВ) и различные биоразлагаемые природные линейные и разветвленные высокомолекулярные соединения (натуральный каучук, целлюлоза, полимеризующиеся смолы, крахмал и др.), имеющие сложный композиционный состав. НВ благодаря своим многочисленным преимуществам все более активно используются в составе полимерных композитов в различных областях применения, вытесняя использование как синтетических (полимерных), так и неорганических волокон. В то же время, несмотря на высокие звукопоглощающие свойства, использование НВ в составе акустических материалов имеет ряд недостатков, связанных с низким уровнем физико-механических свойств и стойкости к воздействию внешних факторов.

В последние десятилетия опубликовано большое количество научно-технических работ, демонстрирующих успешное применение нанотехнологий в самых разных областях, от техники до медицины. Применение нанотехнологий открывает возможности для создания материалов и конструкций с уникальными свойствами, включая вибропоглощающие, звукоизоляционные и звукопоглощающие характеристики. Наименее значимые результаты нанотехнологий достигнуты именно в области акустических материалов. Аддитивные технологии открывают новые возможности получения искусственных структур — акустических метаматериалов, обеспечивающих ранее недостижимые характеристики звукопоглощения в среднечастотном (250–1000 Гц) и низкочастотном (ниже 200 Гц) диапазоне при относительно небольшой толщине конструкции. В научной и технической литературе имеются примеры звукопоглощающих метаматериалов, реализованных по принципу резонаторов Гельмгольца, Фабри – Перо, мембранных поглотителей, резонаторов с разрезными трубками, метаповерхностных

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структур, когерентных поглотителей и др. Рассмотрены преимущества и перспективы использования принципиально новых искусственных мета- и ауксетичных акустических материалов.

Ключевые слова: звукопоглощение, звукоизоляция, композиты, натуральные компоненты, нанонаполнители, ауксетики, метаматериалы.

INNOVATIVE ECO-FRIENDLY ACOUSTIC MATERIALS FOR NOISE PROTECTION IN MECHANICAL ENGINEERING AND CONSTRUCTION (A REVIEW)

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The aim of this work is to analyze the most current trends in the field of creating noise-reducing composite materials used in mechanical engineering and the construction industry.

Global trends indicate that effective innovative materials for reducing structural vibration and noise can be created based on components with high vibration damping ratio over a wide range of temperatures and frequencies These components include natural fibers (NF) and various biodegradable natural linear and branched high-molecular compounds (natural rubber, cellulose, polymerizing resins, starch, etc.) with a complex composition. NF, due to their numerous advantages, are increasingly used in polymer composites in various fields of application, replacing the use of both synthetic (polymer) and inorganic fibers. At the same time, despite its high sound-absorbing properties, the use of NF in acoustic materials has a number of disadvantages associated with an insufficient level of physical and mechanical properties and resistance to external factors.

In recent decades, a large number of scientific and technical papers have been published demonstrating the successful application of nanotechnology in a wide range of fields, from engineering to medicine. The use of nanotechnology opens up opportunities for creating materials and structures with unique properties, including vibration-absorbing, sound-insulating and sound-absorbing characteristics. However, the least significant advances in nanotechnology have been achieved in the field of acoustic materials. Additive manufacturing opens up new possibilities for producing artificial structures—acoustic metamaterials—that provide previously unattainable sound absorption characteristics in the mid-frequency (250–1000 Hz) and low-frequency (below 200 Hz) ranges within a relatively thin structure. The scientific and technical literature describes successful examples of acoustic metamaterials implemented according to the principles of Helmholtz resonators, Fabry-Perot resonators, membrane absorbers, resonators with split tubes, metasurface structures, coherent absorbers, etc. The advantages and prospects of using fundamentally new artificial meta- and auxetic acoustic materials are considered.

Keywords: sound absorption, sound insulation, composites, natural components, nanofillers, auxetics, metamaterials.

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