

Materials and Chemistry

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Antimicrobial Zeolitic Materials With Increased Thermal Resistance, Having A Hierarchical Structure, Comprising Essential Oils

tto.metu.edu.tr
tto@metu.edu.tr

Hierarchically structured antimicrobial nanopores

A more effective, more environmentally friendly and highly thermally stable powdered antimicrobial agent has been developed by encapsulating essential oil molecules with organic antimicrobial properties into hierarchical zeolitic materials with low thermal stability.

Advantages

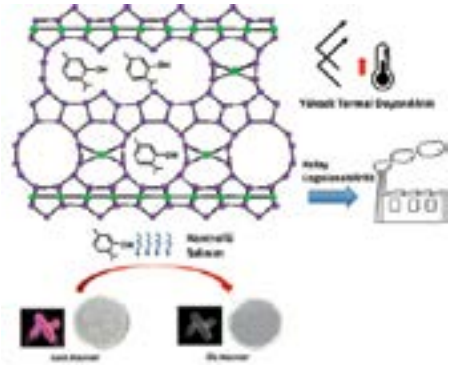
Thermal resistance: High thermal resistance due to encapsulation of antimicrobial essential oils in nanomaterials with hierarchical cage structure.

Controlled release: Gradual release of essential oils into the environment thanks to nanopore size designed according to antimicrobial essential oil molecules.

Low cost: The use of desiccators in the encapsulation method eliminates the use of solvent chemicals compared to liquid mixing methods.

Practicality: Ease of process compared to liquid mixing methods with the use of desiccators in the encapsulation method.

Ease of application: The prepared powder product can be processed more easily in the industry compared to the direct use of essential oils.



An environmentally friendly and thermally resistant solution with the development of cage structures imprisoned with environmentally friendly essential oil molecules instead of harmful antimicrobial agents such as silver

In this invention, a hierarchical pore structure is provided to zeotype nanomaterials containing zeolite or titanium chains whose nanopores are modified by different chemical methods according to the exact molecular size and structure of the cage material.

Thus, the thermal resistance, antimicrobial activity and the duration of antimicrobial activity of these volatile organic molecules have been increased compared to other environmental agents in the market by enabling the placement of essential oils into these nanomaterials. In the invention, for the first time, volatile oil molecules were encapsulated into hierarchical zeolitic material by gas absorption technique without using any solvent, and this technique provided a more effective retention compared to existing techniques. In this way, the use of organic volatile

molecules, which could not be used in applications due to difficulties in processing until now, has been made possible in various sectors as antimicrobial additives.

ODTÜ-23

Lime-Pozzolan Mortars with Bio-Aggregate for Sound Absorption and Thermal Insulation Purposes

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tto@metu.edu.tr

Lime-Based Sound Absorptive and Thermal Insulating Mortars

Lime-pozzolan mortars with bio-aggregate produced for sound absorption and thermal insulation are the mortar products, which have superior breathability, the ability to improve indoor air quality, and self-healing potential. In addition to mentioned properties, these products are environmentally friendly, suitable for local production, and do not contain raw materials harmful to human health.

Advantages

Thermal and Sound Insulation: Lime-based mortar products with good thermal and sound insulation.

Indoor Air Quality Enhancement: elimination of entrapped moisture problem in the building walls and enhancement of indoor air quality provided by high breathability features of the mortar products.

Self-healing Potential: Self-repair of micro cracks which may occur in plaster or mortar over time, in other words, self-healing or self-consolidation of microcracks by infiltration of pure lime into the crack cavities (healing by filling).

Sensitivity to Environment and Living Health: being mortar products obtained from local resources that do not pose a threat to the environment and human health, being low-cost products suitable for local production and industrial production.

Application Area Diversity: They are alternative mortar products that can be used for thermal and sound insulation purposes in new buildings and historical buildings.

It is a mortar product group that offers an alternative product range for new building constructions and renovations as well as historical/traditional building repairs.

By using lime-pozzolan mortars with bio-aggregate produced in various mixtures:
the production of sound absorptive thermal insulating plasters, the production of multi-layered and multi-functional plaster systems and multi-layered insulation board systems for sound and thermal insulation purposes, the production of interior and exterior repair plasters to be used in historic masonry and traditional timber-framed buildings,the production of plasters compatible with timber material that can be applied directly on wooden lath.

The mortar products are obtained from local resources which do not pose a threat to the environment and human health, as well as they are suitable for local and industrial production that can be produced at low cost. Benefitting from the unique properties of pure lime, pozzolanic reactions, and carbonation process, the mortar products which exhibit multi-functional and qualified insulation performances have been produced only with a simple mixture.

Production of Emulsifiers Suitable for Water-in-Oil (w/o) Emulsion Systems Using Corn Cob, Wheat Bran, Sunflower Plate and Fatty Acids

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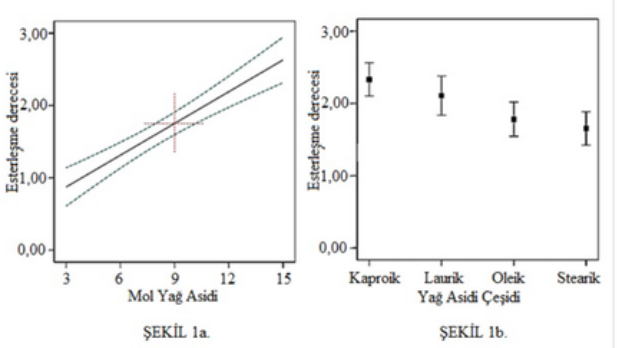
Emulsifiers suitable for oil-in-water (o/w) emulsion systems were produced using food industry residues and thus high value-added end products were obtained from these residues with high cellulose content.

Advantages

Obtaining Value Added Products: Emulsifiers with high economic value are produced by utilizing food industry wastes.

Production Flexibility: Thanks to the use of different raw materials and production conditions, customized emulsifiers can be produced. Thus, suitable products can be designed for various emulsion systems.



Production of emulsifiers suitable for oil-in-water (o/w) emulsion systems using food industry residues

As a result of our studies, emulsifiers suitable for oil-in-water (o/w) emulsion systems were produced by using food industry residues containing relatively short fibers and thus high value-added end products were obtained from these residues with high cellulose content. As a result of the studies, different emulsifiers can be produced for emulsion systems with different oil-in-water ratios by using different raw materials and production conditions. In addition, depending on the raw materials and method conditions used in production, the emulsifiers obtained have different rheological and physical effects in oil-in-water (o/w) emulsion systems. Therefore, it has the advantage of providing different rheological and physical properties of the emulsion system. On the other hand, it is also suitable for use with very different raw materials.

ODTÜ-107

Multi-layered And Breathable Insulated Facade System Providing Passive Ventilation By Allowing Air Diffusion

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An Exterior Facade System

The invention relates to the idea of a multi-layered and breathable insulated exterior wall that provides passive ventilation in the interior environment.

Advantages

Refreshing the indoor air, thus providing more comfortable and healthy indoor environments for users;

It is possible to save energy by reducing the load of natural and mechanical ventilation systems in buildings.

A breathable, ventilated and insulated external wall system

At this point, our invention proposes a fully breathing, ventilated and insulated exterior wall system that will passively contribute to the freshening of the indoor air by diffusion of the wall wall wall on the inside. This proposal is a new wall system that will passively contribute to the freshening of indoor air through diffusion by drilling millimeter holes in the wall board used on the interior façade from the materials that make up the building wall.

Recent studies have shown that airtight building envelopes have a negative impact on indoor air quality. Our invention is a multi-layered, ventilated and breathable façade system that resists air flow but allows gas diffusion at a slow rate, an exterior wall idea that can reduce natural and mechanical ventilation loads and improve both the energy efficiency and indoor air quality of the building.

Production of Emulsifiers Suitable for Oil-in-Water (o/w) Emulsion Systems Using Corn Cobs, Wheat Bran, Sunflower Plate and Fatty Acids

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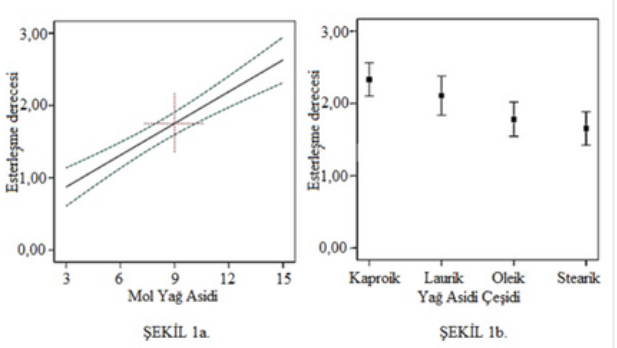

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Bacteriophage Containing Biopolymer Based Surface Coatings with Antibacterial Activity

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Ensuring food safety with bacteriophages and biopolymers

The decrease in the number of bacterial colonies on chicken meat, wrapped with aluminum foil which was coated with bacteriophage incorporated biopolymer based films

Advantages

Using two FDA approved biopolymers in the preparation of ultra-thin films.

Deposition of ultra-thin films onto any substrate such as aluminum foil.

Encapsulation of bacteriophages into biopolymer multilayer films.

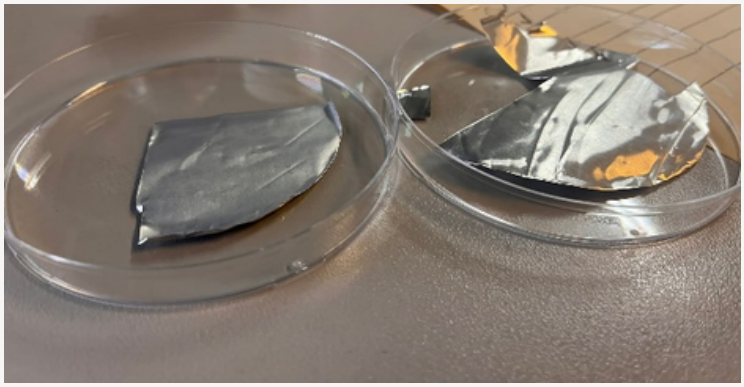
Obtaining antibacterial activity with low amounts of bacteriophages.

The decrease in the number of bacterial colonies on the surface of chicken meat which was wrapped with aluminum foil coated with bacteriophage containing ultra-thin biopolymer film compared to chicken meat wrapped with unmodified aluminum foil.

Extending the shelf-life of food through smart coatings

The invention relates to the deposition of two FDA-approved biopolymers on an aluminum foil support material by layer-by-layer self-assembly and the trapping of bacteriophages in these ultra-thin films.

Alginate and chitosan are a pair of FDA-approved polymers that are safe for human health in contact with food and suitable for forming ultra-thin films on the surface of a solid support material by layer-by-layer self-assembly. Alginate and chitosan multilayer films enable the attachment of bacteriophages within the layers and on the surface of the films.



On the left, aluminum foil coated with phage-containing multilayer biopolymer-based thin films; on the right, untreated aluminum foil with a shiny surface

ODTÜ-124

On-site Cyanide Leach Solution Producing Reactor System

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Cyanore

Ensuring that cyanide is produced as needed, risk-free from simple raw materials, eliminating the costly transportation and storage of dangerious cyanide.

Advantages

Common and cheap ingredients such as urea, lye, natural gas/hydrogen.

On-site production avoids high cost risky transportation of cyanide.

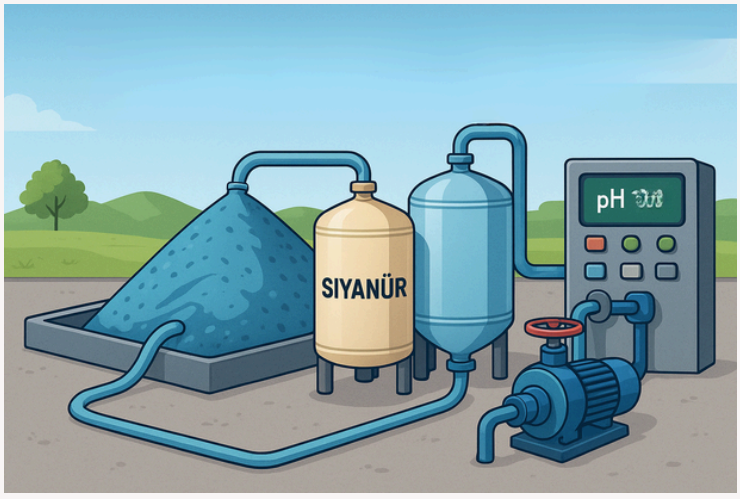
Avoiding the risky storage of high amounts of cyanide and making concentrated solution of it.

With the closed copper reactor that work with siphoning principle, the reactor contents are easily taken into the solution forming tank.

The use of gas as a reducing agent allows the reactor product to be used without the need for an additional purification process such as filtration. Moreover, the option of using green hydrogen as the reducing agent in the reactor opens the way for gold mining to be carried out as carbon neutral.

Make the gold mines able to manifacture required cyanide solution on-site, safely with using common and cheap ingredients.

High temperature reduction of sodium cyanate by a reducing gas agent (i.e. H2,CH4 or CO) , whom was made from urea and sodium hydroxide.



ODTÜ-125

Recovery of Indium From Waste ITO Coated Glass by Electrochemical Method

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Green Indium

Energy efiicient indium recovery was achieved at low temperature by using environmentally benign chemicals.

Advantages

-Low energy consumption

-Low temperature process

-Environmentally benign chemicals are used

-Provides high purity recovery

-Fast

-One step process

Recovery of indium metal, which has a high economic value and is included in the list of critical raw materials by the EU and the USA

Indium metal, which has a high economic value and is listed as a critical raw material by the EU and the US, is recovered from electronic waste at low temperature, using low energy and environmentally friendly chemicals, in a single step, with high purity and without damaging the glass substrate.

Using deep eutectic solvents and their aqueous solutions as electrolytes in electrochemical environment, indium tin oxide is obtained from tin oxide layer in one step with high efficiency and high purity indium powder.

Soft Interface Liquid Crystal Microfluidic Device

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Intersense

The invention is a microfluidic device that ise tailorable for diverse range of applications and processes. It is a small sized, low cost device that is applicable to fast and high throughput analytical applications.

Advantages

Being a fast and low-cost platform

Can be used for different applications (diagnosis of different species, material synthesis)

It can be easily and quickly adapted to the person, location and situation.

Small size

It is environmentally friendly as it does not have a disposable component.

Can be quickly updated (at zero cost) for different diagnostic or synthesis applications

Rapid and comprehensive diagnostics, as opposed to current time-consuming methods of individual analysis

It is a platform that, despite the high cost and time-consuming diagnostic applications of critical and rare diseases, enables periodic analysis in a short time and at a low cost, making early diagnosis easy.
At the same time, it is a platform that allows rapid analysis at the point where environmental and public health can be controlled.

It is a continuous process that enables the synthesis of advanced nanomaterials (2D materials, nanostructured materials, etc.) using interfacial chemistry.

Post-Tensioned Timber Column Frame (PTCF) Earthquake-Resistant Building System

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QuakeSafe FlexFrame: A Post-Tensioned Timber Structural System for Earthquake-Resistant Buildings

Earthquake-proof; negative carbon footprint

Advantages

Earthquake-proof design that ensures maximum life and property safety; immediate post-earthquake usability.

Environmentally friendly and sustainable; utilizes carbon-sequestering timber to combat climate change.

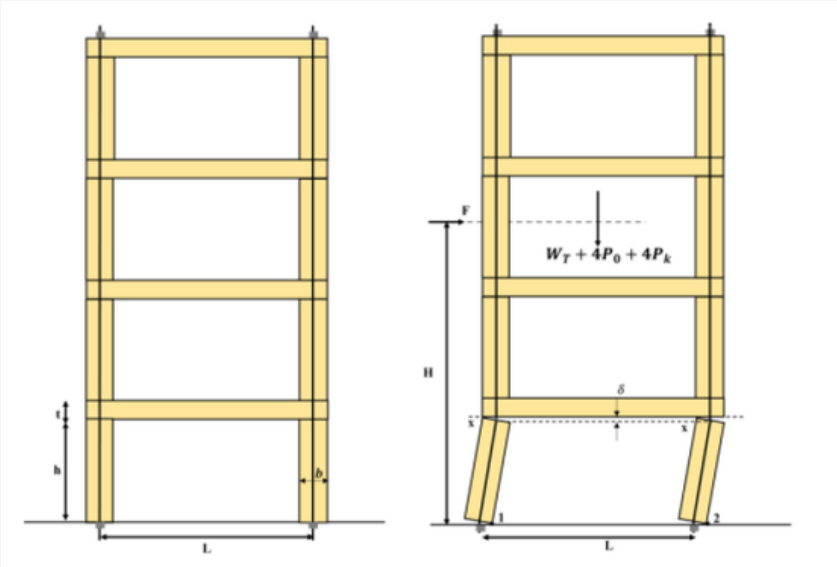
Additional safety walls against extreme earthquake or collapse risk to keep building standing.

Option to add dampers between slabs and safety walls; also fire-resistant with integrated sprinkler system.

Cost-effective; requires smaller foundations on weak soils; unlike seismic isolation systems no need for open space around the building or flexible piping.

Ensures survival during earthquakes; the building remains operational immediately after an earthquake; even under successive earthquakes, the structural load-bearing system remains undamaged.

Use of post-tensioned columns and special connection between rocking columns and slabs-foundation.



ODTÜ-174

Production Of Substitute Material For Asphalt Binders From Recycled Ship-Generated Petroleum-Derived Wastes

Asphalt Additive From Ship-Generated Petroleum-Derived Wastes

The present invention proposes a novel distillation setup and an associated processing method. The proposed method enables the controlled separation of components present in different phases, thereby allowing the production of a systematic and stable product. Through this approach, petroleum-derived ship wastes, which are currently disposed of by incineration in conventional practices, can be transformed into a reliable, standardized secondary product with economic value.

Advantages

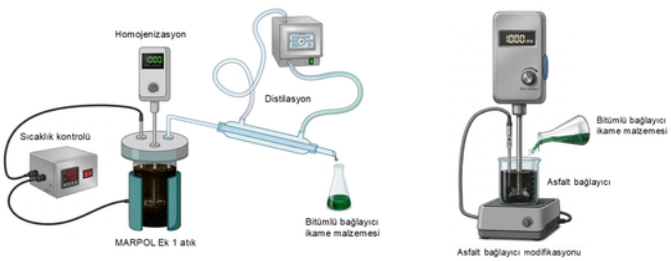
Sustainability: Enables the recovery of petroleum-derived ship wastes within the scope of MARPOL Annex I and their utilization as a bituminous binder substitute material.

Economic efficiency: Reduces asphalt production costs and decreases the need for imported bitumen by converting low-value bottom residue waste into a value-added product.

Innovation: Makes it possible to utilize the bottom residue obtained after dewatering and distillation as a bituminous binder substitute material.

High performance: Due to the compatibility of the physical, chemical, and rheological properties of the obtained product with asphalt binders, it exhibits comparable performance when used with commercial binders.

Environmental benefit: Reduces the amount of waste disposed of by incineration, thereby lowering air pollution and greenhouse gas emissions, while also contributing to the prevention of marine pollution.



The invention provides a solution that reduces costs and enhances sustainability by enabling the use of petroleum-derived ship wastes, which are conventionally disposed of by incineration, as an alternative bituminous material for asphalt binders.

The technical basis of the invention is founded on the design of a product, obtained from heterogeneous wastes through controlled distillation and homogenization processes, to exhibit physical and chemical properties compatible with asphalt binders. Within this scope, it has been determined that the fundamental properties of the obtained product, such as specific gravity, viscosity, and solubility, comply with the technical specification criteria established for asphalt binders.

Furthermore, according to the SARA fraction analysis results, the asphaltene content of the obtained product was found to fall within ranges comparable to those of asphalt binders. FTIR analysis also revealed that the characteristic vibration bands of the product largely overlap, in terms of wavenumber positions, with those of commercial asphalt binders.

Through this multi-parameter compatibility approach, it has been demonstrated that the developed product can be effectively and reliably used as an asphalt binder or as an asphalt additive.

ODTÜ-156

High-Yield Clean Recycling Method of Polylactic Acid with Supercritical CO_2

Eco-Friendly PLA Recycling

Lactide, the raw material of PLA, is produced directly from waste PLA in supercritical CO_2 with high yield, without a catalyst and without generating waste.

Advantages

Direct lactide production: Lactide, the monomer of PLA, is obtained directly from waste PLA. The lactic acid-to-lactide conversion step is eliminated.

No catalyst: Depolymerisation in supercritical CO_2 proceeds without a catalyst, avoiding catalyst cost and catalyst removal steps.

No costly separation: Lactide is obtained without costly separation and purification processes, which simplifies downstream processing.

Shorter process: Skipping the intermediate lactic acid step shortens the overall recycling route, saving time and energy.

CO_2 recovery: The CO_2 used as the reaction medium can be recovered and reused, and the process generates no waste.

Eco-friendly chemical recycling of PLA waste directly into high-purity lactide.

PLA is one of the most widely used bio-based plastics, yet it degrades only slowly under natural conditions, so its waste is a growing problem. Conventional chemical recycling first converts PLA into lactic acid, which must then be turned back into lactide through additional steps.

In the invention, waste PLA is depolymerised in a batch reactor in supercritical or dense CO_2, producing lactide directly.
This skips the lactic acid-to-lactide conversion step and requires neither a catalyst nor costly separation processes. At the end of the process, the CO_2 can be recovered and reused.

Self-Healing Composite Material and Production Method

BiSn NIR Heal TPU

With core–shell BiSn particles at a low loading (0.5%), the film combines high mechanical strength (~46 MPa) with fast photothermal self-healing of up to 89% efficiency while remaining semi-transparent.

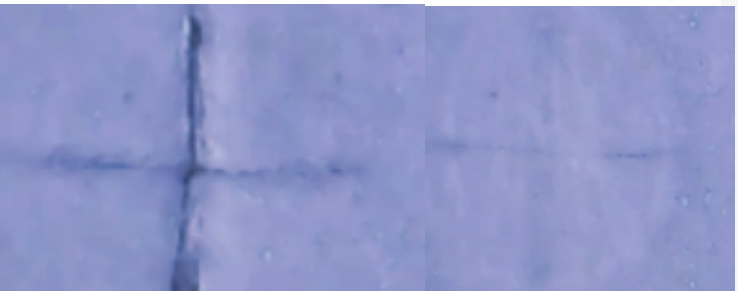
Advantages

High mechanical strength: A tensile strength of about 46 MPa provides sufficient strength for commercial applications.
High healing efficiency: Delivers up to 89% self-healing performance in a short time under NIR light.
Low loading, high yield: High performance with only 0.5% BiSn brings cost and production advantages.
Semi-transparency: Optical transmittance is preserved; suitable for electronic displays, visible surface coatings and packaging.
Local, contactless healing: Heals only the damaged area without affecting the whole structure, offering a controlled, safe and practical mechanism.

A coating that heals cracks under NIR light by heating only the damaged area: both strong and fast-healing.

The invention is based on a thermoplastic polyurethane (TPU) composite film reinforced with liquid-metal particles synthesised in a core–shell structure. The core is a BiSn alloy and the shell is a naturally formed SnO-rich oxide layer; the particles are dispersed homogeneously in the TPU matrix by solution mixing and cast into a semi-transparent film by solution casting.

Under near-infrared light, the high photothermal conversion capability of the BiSn particles causes a local temperature rise in damaged areas. This increases chain mobility and closes the cracks, and the film reaches 89% healing efficiency in about 10 minutes.
The system can be triggered without contact, allowing local and controlled healing.



ODTÜ-192

Heatable Fabrics Coated with Metal Nanowires

Nanowire-Coated Heatable Fabric

Silver nanowires are coated three-dimensionally onto fabric by dip coating, producing a structure that can be heated by an applied current while preserving the breathability and flexibility of the fabric.

Advantages

Breathability: Fabric surfaces are not covered, so the fabric stays breathable.
Minimal material: Thanks to nanotechnology, only a very small amount of active material is used.
Suited to mass production: Produced with a simple method such as dip coating.
Low power consumption: The high electrical conductivity of the nanowires allows operation at low currents with low power use.
Fast, high heating: The high thermal conductivity of the nanowires enables high temperatures at low operating currents.

Fabrics that heat efficiently with low power consumption.

With the invention, fabrics are coated with metal nanowires, and the nanowires are used as heating elements.

The coating lets the fabric breathe, does not impair its flexibility and does not restrict its areas of use.
It reaches the maximum of 60 °C required in many wearable products repeatably and very quickly, holds a constant temperature for as long as needed, and easily returns to room temperature when the direct current is switched off.



TTO-74