A WEEKLY INFORMATION LETTER

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NEWSLETTER

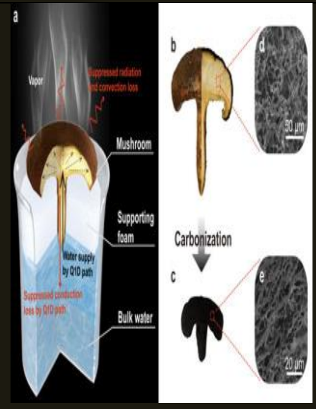
Srinivas Institute of Technology, Department of Nano Technology,

Engineering (B.E.) in Nano Technology, Mangalore, Karnataka, India.

ADVANCEMENTS IN NANO TECHNOLOGY

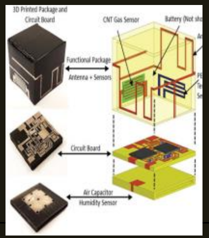
The hidden talent of mushrooms for solar steam generation

For the first time, researchers utilize living organisms – mushrooms – to generate steam under sunlight. It turns out that the micro- and macrostructures of mushrooms possess all the needed characteristics for a good solar steam-generation device: high solar absorption; efficient water supply and vapor escape; and good thermal management. Interestingly, a mushroom is an unlikely candidate as it typically lives in the shadow, i.e. it doesn't get to see sunlight that much. The mushroom maintains its hydrophilicity before and after carbonization because of its components, which include carbohydrates and proteins; the nitrogen functional groups exist even after carbonization. The scientists attributed mushrooms' capability of high-efficiency solar steam generation to their unique natural structures, including their umbrella-shaped black pileus, porous context, and fibrous stipe with a small cross section. First, the umbrella-shaped black pileus can absorb a huge amount of solar energy. Second, the hydrophilic fibrous stipe working as efficient water supply path can pump water into the mushroom context by capillary force. Third, the porous context not only acts as a bridge to pump the water further into the top pileus but also provides sufficient vapor channels. The ratio of the areas of fibrous stipes and black pilei is so small that only little heat (useless heat loss) conducted into water. In addition, the umbrella-shaped pileus with a large surface-to-projected area ratio not only provides a large surface area for evaporation but also minimizes the loss from radiation and convection. To fabricate their solar steam generation device, the team carbonized shiitake mushrooms. Although the entire structure of the mushroom shrinks by about 30% during this process, the carbonized mushroom maintains a porosity similar to that of the natural one (~90%). However, the surface roughness of the pileus increases, which is beneficial for light absorption. Due to the reduced reflection, this results in a dramatically increased absorption of solar energy – 96% after carbonization versus 79% of the natural mushroom.



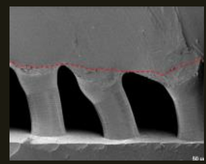
3D-printed, fully integrated wireless sensor devices

Self-sustaining sensor platforms to continuously monitor the surrounding environment are core components for Internet-of-Things (IoT) and smart-grid systems. These sensor networks will lead to new applications in security, health and environmental monitoring. To make this practicable, the sensors need to be highly integrated, low-cost and small size. Researchers have now demonstrated a fully integrated and packaged wireless sensor for environmental monitoring applications. The disposable sensor was developed using low-cost additive manufacturing technologies; namely, inkjet printing and 3D printing. Already, passive components such as inductors, capacitors and antennas have been fabricated via additive manufacturing processes such as 3D printing and inkjet printing. Researchers have also demonstrated 3D-printed sensors. However, there has been no demonstration of 3D-printed fully-integrated System-on-Package (SoP) employing inkjet-printed sensors. The significance of our work is the demonstration of a highly integrated, 3D-printed functional package which not only encloses the traditional electronics but also has sensors and antennas inkjet-printed on its walls. Such a System-on-Package has not been shown before using additive manufacturing technology. This work could pave the way for low-cost disposable fully integrated wireless sensor nodes. The team developed a wireless sensor node that incorporates multiple fully inkjet-printed sensors to monitor humidity, temperature, and H2S gas levels. The sensors have been inkjet-printed on the walls of the 3D-printed sensor package which has resulted in a reduction in size of the wireless sensor node. The cube-shaped functional package also contains the 3D antenna which ensures equal radiation in all directions, thus enabling orientation insensitive communication. The microelectronics has also been realized on a 3D-printed circuit board that is enclosed in the package.



Making skin sensors stick

Research groups around the world are taking big strides towards developing ultrathin and flexible sensor devices that could be attached to the skin, or even organs, and monitor vital body functions. One recent example is a wearable graphene-based piezoresistive strain sensor to monitor human vital signs. Another example is a wearable, low-cost nanowire sensor to measure skin hydration. However, the adhesion to skin of many of these sensor patches is weak. A new milestone study on skin adhesives for wearable devices is about to change that. Researchers recently showed that they can strongly and non-invasively attach soft wearable sensors and other devices to dry or wet skin. They have developed a facile method for superior conformation and adhesion of bioinspired composite microfibers to the hierarchical topography of soft and textured skin. These soft and stretchable skin-adhesive micropatterns are composed of poly(dimethylsiloxane) (PDMS) microfibers decorated with conformal and mushroom-shaped vinylsiloxane tips. Researchers show that crosslinking of these viscous tips directly on the skin surface can greatly enhance the skin adhesion through their excellent shape conformation to the multiscale roughness of the skin. After optimizing the pattern geometries and processing parameters, the skin-adhesive films achieved high adhesion strength of up to 18 kPa. The team chose vinylsiloxane as skin interfacing material due to its several features that can influence the skin adhesion: it is developed and approved for biomedical applications; as a two-component material possesses much faster cross-linking kinetics than other elastomers; its suitable viscosity enables successful transfer-patterning process and texture/roughness conformation; and it belongs to the family of silicone rubbers and allows covalent bonding with base PDMS microfibers.



Nano products

Envirox™ Fuel Borne Catalyst

This is the product of Oxonica® Ltd., from UK. Envirox™ Fuel Borne Catalyst is a scientifically and commercially proven diesel fuel combustion improve which reduces fuel consumption and also reduces harmful exhaust emissions. These benefits are achieved by using a patented catalyst technology based on cerium oxide, a well-known industrial catalyst, which is also used within the automotive sector in gasoline engine three-way catalytic converters. Envirox™ is delivered into the combustion chamber pre-mixed with the fuel and improves fuel consumption using two mechanisms: - cerium oxide modifies the combustion profile so that more useful work is delivered from each combustion cycle for a given quantity of fuel - cerium oxide lowers the temperature at which carbon combusts which causes a progressive cleanup of the engine allowing the engine to operate with optimum efficiency. The concentration of the nano particles is 5 PPM.

Fast Seal

The product is of company Nanosafeguard, USA. Intended for all cars. This easy-to-apply sealant uses custom nano particles to provide superior protection in very few steps. It lasts up to 1 year and can be used both alone or as a protecting coating under wax or other gloss enhancing products. Silicon dioxide is the nano material used in this product.

EDITORS

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STUDENT EDITOR

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