U.S. TECH

www.us-tech.com

VOLUME 33 - NUMBER 7 THE GLOBAL HI-TECH ELECTRONICS PUBLICATION July, 2018

Product Preview:

SEMICON West

EPCOS, a TDK Group company, launches new high-voltage contactors. Product previews begin on…

Page 64

SpecCoat Relies on PVA Dispensing

Specialized Coating Services (SpecCoat) benefits from PVA automated dispensing platforms. EMS section begins on…

Page 18

This Month's Focus:

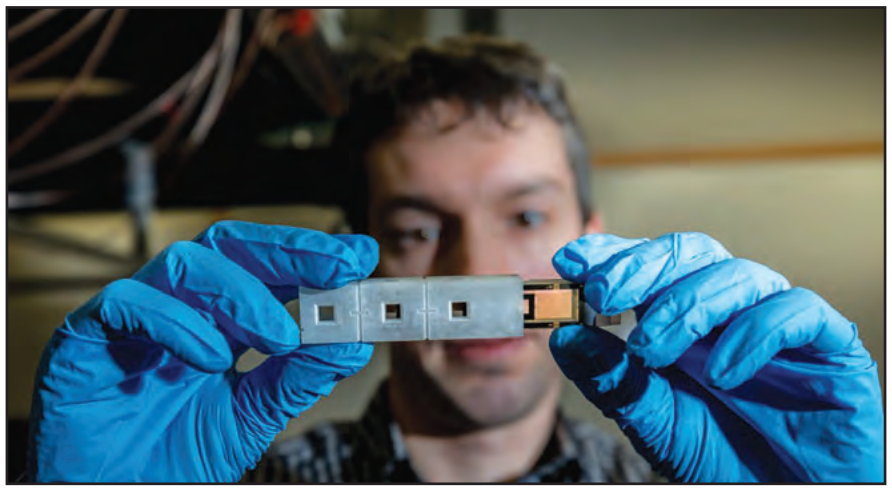
Production and Packaging

BTU creates custom high-temperature furnaces; Mentor puts "design" back into DFT; PVA TePla enables high-throughput scanning acoustic microscopy in the fab....

Page 52

Measuring Minuscule Magnetic Fields

Atlanta, GA — Measuring very small changes in the brain's magnetic fields could lead to a better understanding of maladies, such as epilepsy, post-traumatic stress disorder (PTSD) and traumatic brain injury. However, the equipment used for such measurements today is bulky and expensive. Scientists and engineers at Georgia Tech Research Institute (GTRI) want to address that issue by creating a new generation of atomic magnetometers based on clouds of rubidium atoms.



Atomic magnetometers could lead to better brain imaging and GPS-denied navigation.

"Currently, there are no commercially available magnetic sensing devices with sufficient sensitivity that are portable, yet there would be many potential applications for that technology," says Robert Wyllie, a GTRI research scientist leading the project. "We want to determine how to make a portable array of very sensitive atomic magnetometers that can be used outside of a magnetically shielded room."

Isolating Magnetic Fields

The main challenge being addressed by the research is determining how the minuscule magnetic fields of interest can be measured apart from the massive fields created by the Earth — and by artificial sources, such as electronic equipment. The project, which is fabricating its first vapor cell for holding rubidium gas, will tackle the challenge by looking at both the basic physics and the signal processing required.

Superconducting quantum inter-

Continued on page 6

Metal-Polymer Conductors Enable Stretchable Circuits

Beijing, China — Researchers in China have made a new hybrid conductive material — part elastic polymer and part liquid metal — that can be bent and stretched at will. Circuits made with this material can take on most two-dimensional shapes and are also nontoxic. A paper detailing the work was published in the journal *iScience*.

"These are the first flexible electronics that are both highly conductive and stretchable, fully biocompatible and able to be fabricated conveniently across size scales with micro-feature precision," says senior author Xingyu Jiang, a professor at the National Center for Nanoscience and Technology. "We believe that they will have broad applications for both wearable electronics and implantable devices."

The key material is called a metal-polymer conductor (MPC), which is a combination of two components with very different, yet equally desirable, properties. The metals in this case are not familiar conductive solids, such as copper, silver or gold, but rather gallium and indium, which exist as thick, syrupy liquids that still permit electricity to flow. The researchers found that embedding globs of this liquid metal mixture within a supporting network of silicone-based polymer yielded mechanically resilient materials with enough conductivity to support functioning circuits.

The LED circuits interconnected by MPC can undergo repeated bending, twisting and stretching.

Up close, the structure of the MPC can be likened to round, liquid, metal islands floating in a sea of polymer, with a liquid metal mantle underneath to ensure full conductivity. The researchers successfully

Continued on page 8

Tuning Electron Groups in Semiconductors

West Lafayette, IN — The way that electrons paired as composite particles or arranged in lines interact with each other within a semiconductor provides new design opportunities for electronics, according to recent findings by researchers at Purdue University.

What this means for semiconductor components, such as those that send information throughout electronic devices is not yet clear, but hydrostatic pressure can be used to tune the interaction so that electrons paired as composite particles switch between paired, or "superconductor-like," and lined-up, or "nematic" phases.

Using Hydrostatic Pressure

Forcing these phases to interact also suggests that they can influence each other's properties, like stability, opening up possibilities for manipulation in electronic devices and quantum computing.

"You can literally have hundreds of different phases of electrons organizing themselves in different ways in a semiconductor," says Gabor Csathy, Purdue professor of

Continued on page 8

Cleaning and Etching Items with Unique Geometries

By Jeff Elliott

Cleaning, an integral part of many manufacturing and maintenance processes, is often critical to the performance of a broad range of technologies in the semiconductor, defense, MEMS, photonics, and biotech industries.

"Cleaning," in this case, refers to the use of agents, such as solvents, acids or bases, to remove unwanted particulates and other contaminants from products that range from optics to semiconductor and electronic devices.

It also refers to the etching process in semiconductor fabrication, where the cleaning is the precise removal of thin layers of material. Today, many of these processes are relatively standardized. Semiconductor wafers, for example, are produced in several sizes and processes the same way, no matter the type.

Odd Shapes and Sizes

However, for products with non-standard geometries, shapes, sizes, and even weights, cleaning becomes more challenging. This involves figuring out how to get each item in and out of the equipment at each stage of processing.

In this category are a variety of items, such as optical lenses for the world's largest telescopes and high-energy lasers, the crystals used in nuclear sensors or guidance systems, glass substrates, MEMS devices, probe sensors, medical implants, chemically machined subcomponents, and many others.

These types of items require creative solutions to load items in and out of what it typically a multistage process. This can include using automated gantry robots, machined fixtures and loading carts.

Careful consideration must also be given to the orientation and, potentially, the rotation of the item after it enters the process baths.

Wet processing chamber for cleaning and etching.

"We are not just concerned with the cleaning equipment, but also how to get the products in and out of that tool," says Louise Bertagnolli, president of JST Manufacturing, a specialist in wet processing and precision cleaning equipment. The handling of non-standard items of various geometries is a factor that most customers do not consider.

"They focus almost solely on the cleaning process — the temperatures and chemical concentrations," she says. "Yet, product handling can impact the amount of chemicals required, processing time and even quality of cleaning."

Using Gantry Robots

Companies that choose to automate a cleaning process usually do so to ensure the repeatability of cleaning results. This means precisely controlling the measurement and dispensing of the cleaning agents and rinsing solutions. It also means providing the systems and tools necessary to transport the items from one bath to another.

For this, robots are often used to lift and transport items to multiple stations or modules. At companies like JST, this requires working closely with automation partners, such as Bosch Rexroth, to develop cleaning stations using linear motion and electric drive and control technology.

In a recent project, the two firms worked together to create an automated system for cleaning silicon chunks to the extreme purity of 11N to meet requirements for the manufacturing of semiconductor chips. The project involved building a cleaning line 138 ft (42m) long and incorporating multiple gantry robots.

The throughput volume requirement for the chunks was four tons per 22-hour shift. To accomplish this, JST had to develop a custom basket sys-

Continued on next page

Cleaning and Etching Items with Unique Geometries

Continued from previous page

tem to transport the material throughout the process.

To provide for such a long cleaning system, JST engineered and built it in two parts. In a 24 ft (7.3m) segment, baskets of chunks are manually loaded through an auto-door. Then two-axis robots cycle the baskets through five acid etch baths and two rinse baths arranged in a single row down the length of the second unit.

In some cases, gantry robots are the only solution, particularly for heavy items that may be too much for workers to handle safely. Bertagnolli has seen products to be lifted exceed 100 lb (45.4 kg).

In a project for Lawrence Livermore National Laboratories' National Ignition Facility (NIF), JST was charged with figuring out a solution for handling thousands of heavy optical lenses.

NIF operates one of the world's highest energy laser systems, which consists of 192 laser beams that can focus nearly two million joules of energy. Each of the beams is supported by up to 50 lenses.

"If these lenses were not as clean as possible, then we would start to degrade the performance of our laser," explains Patrick Williams, NIF optics maintenance manager.

"The optics are heavy and rather large, so we don't want to handle them a lot," he adds. "JST suggested that there might be an easier and more cost-effective way to transport, clean and inspect the optics. They came back with an original design, and then we tweaked it into a system that has worked for over 16 years.

Given that so much is invested in the cleaning process tool, it makes sense to ensure repeatability with an appropriate handling system. JST can complete a structural analysis and look at the deflection before anything is built.

One of the innovations in the NIF cleaning tool, which was a tank-like configuration, was to eliminate the need to move the optics to different locations to perform the washing, rinsing and drying functions. Rather than moving the optics, all cleaning, rinsing and drying is done in one tank. The chemistries move, not the product.

Machined Fixtures

Bertagnolli says another important element to consider is the fixturing. Single- or multi-item fixtures are typically designed and machined to fit the specific application. Because precision cleaning equipment is largely a task involving metal fabrication and machining, suppliers like JST can also provide custom fixtures. Well-designed fixtures can even accommodate quick-change inserts that allow them to be reused for other parts.

Orienting the Part

It is important to optimize the orientation of the part if it has blind holes or other geometric features facing upward that can hold chemistry when lifted out. The same holes, if horizontal, can create unwanted bubbles or air pockets.

For these reasons, it might be necessary to design a solution that orients the part in a certain direction and then rotates it later in the process. Even if no blind holes are involved, etching the entire surface of a part may require rotating the part while minimizing contact with the surface.

Such was the case in a project JST undertook that included the cleaning of silicon seed rods that grow the polysilicon ingots from which the chunks are made. The seed rod cleaning equipment used a gantry robot to move the ingot-carrying cylindrical carriages through a sequence of etch baths. JST designed a custom fixture that rotates the rods to ensure they etch evenly.

"The rotational fixture enables the rods to be cleaned to a very high purity," says Bertagnolli. "We incorporate rotational fixtures quite often for cleaning."

Attention Early in Design

Sufficient consideration of these factors must be given early in the design phase. Racks and fixtures need to be designed to safely handle parts, and the fixtures themselves must be designed to withstand the chemicals involved. With a full engineering staff and 3D modeling, JST can complete a structural analysis and look at the deflection before anything is built.

Given that so much is invested in the cleaning process tool, it makes sense to ensure repeatability with an appropriate handling system.

Contact: JST Manufacturing, Inc., 219 E. 50th Street, Boise, ID 83714 ☎ 800-872-0391 fax: 208-377-1120 E-mail: info@jstmfg.com Web: www.jstmfg.com ❒

See at SEMICON West, Booth 1605