



BMDO Update

Linking American Businesses to Ballistic Missile Defense Technology

This article is reprinted from the *BMDO Update* newsletter, a publication of the BMDO Technology Applications program.

FALL 2000
ISSUE #35

Fractal Systems' capacitor replaces the sulfuric acid electrolyte with an alkaline electrolyte. The result is less corrosion at the electrode, which extends capacitor lifetime and improves performance.

POWER AND PROPULSION

NEW DEVELOPMENTS TO INCREASE CAPACITOR LIFETIME

Today's electrolytic capacitor has proven itself effective, but at a price: it uses a corrosive sulfuric acid electrolyte that reduces capacitor lifetime by eventually destroying the carbon electrode. Additionally, the harsh liquid must be contained in resistant packaging, driving up capacitor cost and weight. With the help of BMDO SBIR funding, Fractal Systems, Inc. (Tampa, FL), is developing an electrolytic capacitor that does not require sulfuric acid. It will offer a longer lifetime while still providing high power density in a compact and affordable package.

Replacing the corrosive electrolyte required an affordable new electrode material that would at least match the performance of the carbon/sulfuric acid combination. In transition metal nitrides, Fractal Systems researchers found an alternate material that has a potentially higher

surface area than carbon (greater surface area leads to higher capacitance) and is more conductive. To make the high-surface-area nitrides, the company developed a room-temperature process for producing nitride nanoparticles and thin films. This process avoids the surface area-reducing agglomeration that occurs in high temperature processes.

With a nitride electrode, Fractal Systems can use less corrosive potassium hydroxide (KOH) as the electrolyte. KOH has a high ionic conductivity and also a low freezing point, which can extend the capacitor's range of applications. And without sulfuric acid, there is no need for highly resistant casing materials, therefore the devices can now be packaged in materials such as aluminum, polyethylene, and Teflon®.

The new capacitor ranges in size from under 1 square inch—important for miniatur-

ized munitions fuzing—to as large as 6 by 6 inches. It offers a wide operating voltage between -1.3 to +1.3 volts and has a freezing point of about -55°C, beyond the -40°C operating specifications for many battery applications. Capacitor manufacture is handled by Evans Capacitor Company, which is currently building a 12-volt prototype for an automobile parts manufacturer. Fractal Systems seeks additional partners or investors to help it fully optimize the capacitor technology for mass markets.

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ADVANCED MATERIALS

POLYMER OFFERS DISPLAY ALTERNATIVE TO INDIUM TIN OXIDE

Conductive polymer coatings are emerging as a more robust and flexible alternative to indium tin oxide (ITO) for liquid crystal displays.

Fractal Systems, Inc. (Tampa, FL), has developed transparent polymer coatings with copper-like conductivity. Although there are a variety of commercial and military applications for this technology, entering the liquid crystal display market is the ultimate goal of the company. Currently, Fractal is pursuing applications in solid-state lighting, optical device coatings, and electromagnetic shielding. BMDO, now MDA, funded Fractal to develop multifunctional conductive polymers for broad-frequency radiation hardening applications.

Fractal's polymer films can be used in conjunction with or to replace ITO, the current display industry standard. The copper-like conductivity of Fractal's polymer is three to four orders of magnitude higher than existing conductive coatings. The polymer is applied using traditional chemical processes at atmospheric conditions, which costs less than conventional methods. ITO is applied using an evaporation process, which results in pinholes in the ITO thin films. Correcting this problem requires laying down thick layers of ITO, resulting in lower transparency to visible light, limiting the devices' tolerance to mechanical stress and flexibility. Fractal can obtain a very homogenous polymer film without pinholes at sub micron-level thickness, increasing robustness and flexibility. Creating a liquid crystal display is a difficult process that involves layering polymers, dividing it into pixels with high resolution, and developing circuitries that connect each pixel with

a transistor. A possible beginning for Fractal is the small display market, such as cell phones and telephones, because there are not as many pixels and resolution is not as important.

Fractal is working with investors on another application of its polymer technology: solid-state lighting. Fractal's thin-film polymer is more efficient in lighting applications because it is nearly 100 percent transparent. Conventional thin films are still too thick to allow complete transparency. Solid-state lighting is also a low-power application because the light can run on just a few volts of electricity.

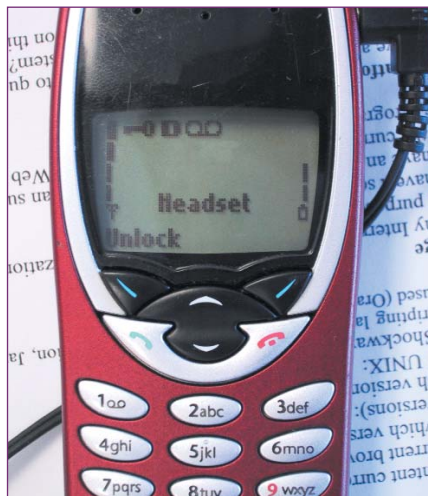
The coating capability of Fractal's polymer has generated interest in the defense industry as well. The company is currently talking to a defense contractor about using the polymer to hard-coat optical devices. Fractal's polymer is capable of being transparent in the visible through the infrared (IR). Many

of the military's optical devices operate on the mid-wave IR range; therefore the coatings that protect the lenses must transmit IR. Currently, the military uses an ultra-violet (UV) filter and hardening coat—both absorb IR making the signals weak. Fractal can eliminate the need for conventional hardening and UV coatings with its polymer, which can achieve more than 90 percent transmittance of the IR signal.

Another military application that is being discussed is using the polymer to shield the optics on military weapons, such as missiles, from electromagnetic signals. A window in the weapon transmits the IR signal to the electronics, but a destructive electromagnetic signal can enter as well. The conductivity of Fractal's polymer will shield the electronics from electromagnetic pulses while allowing the IR signals to pass through.

Fractal is poised for growth and ready to hire more employees in the next year. The company is interested in obtaining partners in device manufacturing to expand on applications of its polymer.

—T. Spitzer



Small display. Fractal's polymer films are ideal for small displays, such as those in cell phones, where fewer pixels and lower resolutions are tolerated.

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