Nanocomposite coatings: superior thermal management in Energy, Aerospace & Infrastructure

By

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A new nanotechnology-enhanced coating product from NanoRidge Materials Inc. is poised to change the way industries and consumers survive cold temperatures and protect equipment, fluids, and products from the damage and delays associated with freezing and static discharge.

The new product, known as NEETcoat®, is a sprayable, resistively heated coating that can be applied to a wide range of materials and can reliably and efficiently generate surface temperatures from 5°C for freeze protection to over 300°C for rapid fluid heating. The product offers superior durability, versatility, and cost effectiveness compared to conventional heating approaches and is currently being introduced into markets ranging from oil & gas, wind energy, and aerospace to construction and infrastructure.

Unique properties

In 2004, NanoRidge Materials Inc. licensed 16 patented foundational technologies from Rice University to harness the potential of nanotechnology-enhanced composites and exploit their unique properties in a variety of commercial markets including heatable coatings. Now, after nearly a decade of engineering, research and development, the Houston-based small business is launching the first product from its NEET™ technology family.

NEET™ (NanoEnhanced ElectroThermal) technology broadly describes proprietary techniques to incorporate electrically- and thermally-conductive carbon nanoparticles into host matrices including polymers, plastics, metals, fibres and ceramics. The resulting nanocomposites exhibit increased electrical and thermal performance enabling applications such as static dissipation, electromagnetic interference protection, power transmission and electrothermal heating. The first product resulting from this technology is NEETcoat®, which is a durable and versatile polyurethane-based coating system that can be used for static dissipation and electrothermal heating.

For static dissipation, NEETcoat® is substantially more conductive than conventional carbon- or metal-filled polymers and offers superior charge dissipation performance as well as improved durability. It can be applied either during factory production or in the field using conventional spraying equipment. Once applied and connected to a grounding system, the coating will efficiently drain static charges

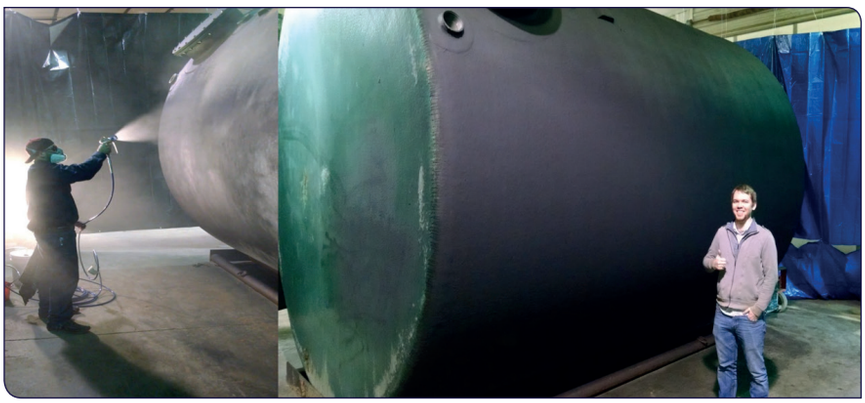

Fig. 1: Applying NEETcoat® with an airless sprayer (left); glass fibre tank prototype with NEETcoat® for static dissipation protection (right)

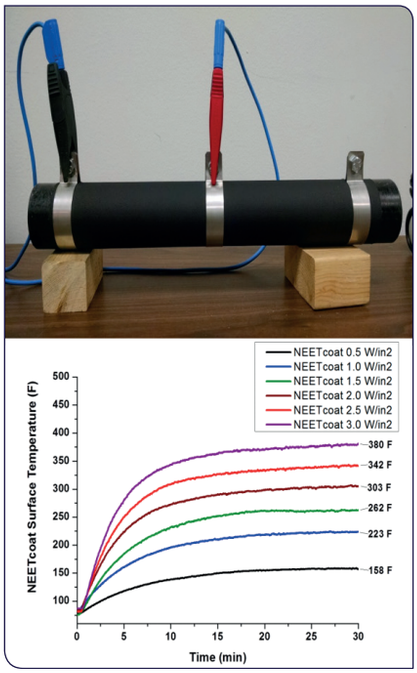

Fig. 2: NEETcoat® applied to pipe (up); graph of NEETcoat® surface temperature compared to applied power density (down)

and protect critical components and structures from damage. Field trials are underway for a 3.7-metre diameter glass fibre tank as depicted in Figure 1.

Versatile uses

As an electrothermal heater, NEETcoat® is a versatile, lightweight and corrosion-resistant product that produces heat when electric current is applied. It can be used to efficiently heat composite, ceramic, metal, or plastic surfaces for various applications including anti-icing (aerospace or wind energy), hydrate and wax remediation (down-hole or subsea oil & gas), and general thermal management including viscosity control and freeze prevention. The system only weighs ~915 g/m^2, is easily applied to complex surfaces, and exhibits superior durability and thermal versatility; therefore, it offers many performance and operational cost benefits over competitive heating systems. The system is implemented by, first, properly preparing the surface and applying an insulating primer coat (in the case of a metal surface).

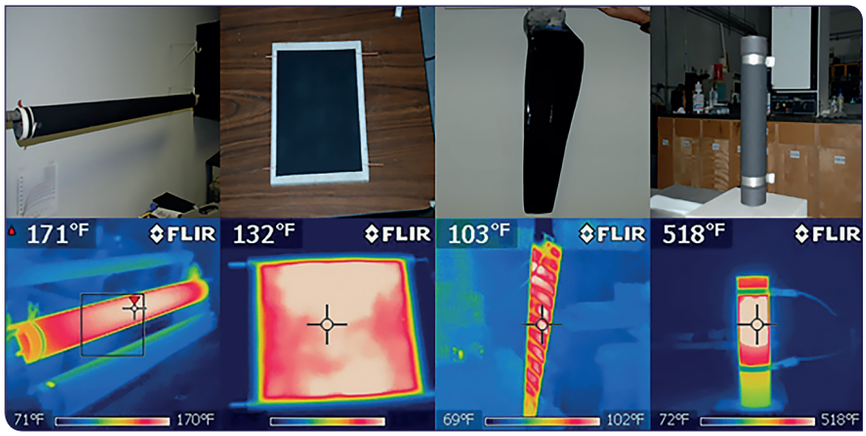

Fig. 3: Examples of materials heated with NEETcoat®, from left to right: 1) 76-mm OD carbon steel pipe, 2) cement board panel, 3) epoxy composite wind blade, 4) steel pipe prototype of High Temp NEETcoat®

Next, it is applied using airless or pressure pot spray equipment and electrical leads, preferably thin metal strips or bands, are integrated where heating is desired.

Finally, an insulating topcoat may be applied for safety and additional durability. Connecting the leads to a power supply capable of providing the required power density will generate heat as demonstrated in Figure 2.

Thermal performance

NEETcoat® can be energized with either alternating or direct current and its thermal performance (ramp rate, surface temperature, BTU output) can be controlled by an electronics system integrated into the power supply. The polyurethane NEETcoat® system exhibits excellent chemical and abrasion resistance, adhesion to a wide variety of substrates, and a maximum continuous operating temperature of 120°C, making it ideal for many uses. For more demanding applications, a higher temperature system is under development capable of operating temperatures in excess of 315°C.

The products are protected by multiple US and worldwide issued patents and patents pending with priority dates as early as 2004, offering critical market protection to affiliates and customers. Selected examples of materials enhanced with NEETcoat® are shown in Figure 3.

Oil and gas

In 2014, NanoRidge established NEETcoat, LLC as a joint venture to commercialize NEETcoat® into target markets including oil & gas, aerospace, chemical processing and infrastructure. Since its inception, NEETcoat, LLC has engaged nearly 50 potential customers, developed multiple prototypes and installed the NEETcoat® system for field trials in California and Oklahoma. Several prototype testing programmes are underway including a successful demonstration that the coating system when applied to a 3-m long, 405-mm diameter pipe can control the temperature of heavy crude oil to prevent wax solidification, inhibit hydrate formation and optimize flow parameters.

The company recently entered into agreements with an oil and gas service organization in California and UK-based nanomaterial merchant Fullerex to identify and exploit near-term market opportunities. It has also teamed with Thermal Coat Technologies of Michigan to introduce NEETcoat® into infrastructure and construction markets. ■

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