Sugama’s Smart Coatings Can Change the World

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Since the start of the Industrial Revolution, it was just accepted that machines break down. Bridges, automobiles, and sailing ships rust and corrode. Water lines crack and flood neighborhoods. Pipes and factory equipment constantly fail and need replacement. Billions of dollars in repairs, human injury, environmental pollution, and lost production are the results of these mishaps. However, recent work at Brookhaven National Laboratory suggests that the future may be much, much, different.

In 2002, BNL researcher Tushifumi Sugama earned the R&D 100 prize for the development of Curralon, a smart, high-performance coating used to protect carbon-steel tubes and piping (Brookhaven National Laboratory). The coating system dramatically improved the durability of power plant pipes, extending the need for repairs from an average of six months to over five years. Further, the reduction of corrosion greatly improved the efficiency of these plants.

Sugama's Curralon is not simply paint (Celanese Chemicals). It has three layers. The inner layer, closest to the steel pipe, is a ceramic layer that bonds to the metal. The middle layer consists of carbon-fiber reinforced polyphenylenesulfide (PPS). This adds tensile strength, corrosive protection, and thermal conductivity to the pipe. The outer layer is an alloy of PPS and polytetrafluoroethylene (PTFE) containing calcium bialuminate and carbon fibers. This outer layer serves to protect and monitor the condition of the inner layers and the pipe. The bialuminate essentially "heals" small microscopic cracks in the polymers around the pipe by promoting the growth of mineral crystals within the defects.

The results are dramatic (Celanese Chemicals). Curralon decreases metal rusting by a factor of 30 to 40 times the present rate. It increases steel's resistance to abrasion by a factor of 100. It works at all levels of pH and to high temperatures. Curralon is expected to be used not only for power plant piping, but also in chemical, water treatment, air conditioning, and desalination plants.

Curralon is but one of a new generation of "smart coatings" that protect structures, adjust to the environment and prolonged the life of buildings and other manufactured structures like airplanes, ships and building (Challener). Many use state-of-the-art polymers and recent breakthroughs in nanotechnology. Obviously, their uses go far beyond just metal pipes and containers.

Our armed forces-Army, Navy and Air Force-are greatly interested in this technology (Azonano.com). Smart coatings not only improve the durability of battlefield equipment such as tanks and trucks but may be able to adapt to the environment and change color, dramatically improving the ability to camouflage our troops. Self-healing or corrective coatings can dramatically protect Navy destroyers and aircraft carriers from corrosive sea water. Given the shuttle's difficulty with broken heat tiles, the Air Force and NASA are obviously investigating self-healing coatings for jets and satellites. Recent work involves an outer layer of crystals that can detect a crack and, then, automatically initiate polymerization and repair.

These coatings have uses beyond the military. In medicine, smart coatings can improve patient care and prolong lives (Challener). Present implants such as catheters and cardiac pacemakers can become infected or cause clotting in the blood stream. Smart coatings can respond to the presence of biological materials such as bacteria cells or

clotting proteins and prevent their growth or attachment, respectively. Outside the body, new paints have been developed that prevent the growth of bacteria and viruses. Their use in hospitals or nursing homes can significantly decrease transmitted infections and the spread of disease.

These coatings may affect everyday life, not just that seen in factories, hospitals, or battlefields. One can just imagine self-cleaning windows. Nanoparticle-filled coatings can act as a catalyst. Activated by ultraviolet rays in sunlight, these particles can loosen dirt. Furthermore, computer, iPod screens, or even automobile finishes can become scratch-free. These improvements would reduce the need for routine paints, cleaners, and solvents, ultimately reducing a significant amount of pollution (Wired News).

Toshifumi Sugama's R&D 100 award concerning Curralon is only another discovery made at BNL that will significantly affect our future. Curralon, and other similar "smart coatings" will affect us from industry to home to health care. Sugama was being humble when he described his achievement as "a giant leap forward."

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