CHEMICAL & ENGINEERING NEWS
OCTOBER 14, 1985

Self-adhesive Polymeric Coatings Have Nonstick Surfaces

Thin films reduce drag at solid-fluid interfaces; offer such uses as coatings for boat hulls, dental structures, and cardiovascular prostheses

One of life's excruciating tasks—scraping barnacles and other marine aggregations off boat hulls—may soon lose its pain. A polymeric material developed by a Tampa, Fla., scientist is proving effective in tests as a coating that resists adherence of marine organisms and also reduces drag.

However, notes Keith Kent, president of Kent Integrated Scientific Systems (KISS), use of the material as a marine coating is only part of the story. The technique he developed prepares self-adhesive polymeric coatings that readily adhere in thin films to most solids—requiring no primers or other pretreatments—and produce a highly stable, nontoxic, nonstick surface that reduces drag at solid-fluid interfaces.

Barnacles and other marine growths from nine months in ocean are easily wiped off KISS-COTE-coated plate (left), resist removal on uncoated plate

He envisions a vast variety of possible applications beyond marine coatings, including coatings for cardiovascular prostheses and dental structures, wood preservatives, and car and airplane coatings.

Kent started the small Tampa firm last December to develop products based on research he began in 1979. He has training in both chemistry (a B.A. degree) and dentistry. Collaborating with him are chemists Robert E. Baier of the State University of New York, Buffalo; and Herman Gucinski of Anne Arundel Community College, Severna Park, Md. Kent discussed some of his work at American Chemical Society national meetings, both last month and in March 1983.

Kent's research on the coatings began when as a dentist he tried to understand the physical and chemical principles determining the bond strengths of prosthetic skin adhesives. His specialty, maxillofacial prosthetics, involves providing artificial replacement parts for missing structures in the head and neck region, usually using silicones and other high-molecular-weight polymers that are relatively inert and biocompatible. Prosthetic skin adhesives are frequently used to bond the prostheses in place, instead of, or in addition to, mechanical retention. However, the inertness that makes the polymers suitable for prostheses also means that the adhesive cannot bond chemically to the prosthetic material, but must instead be bonded mechanically.

Kent sought methods of augmenting the prosthesis-to-adhesive and adhesive-to-skin bond strengths. His work led to development of a new intrinsic prosthetic skin adhesive. Control and modification of polymerization conditions—with resultant changes in the surface chemistry and character—also led to materials that can selectively bond to most substrates without use of caustic or highly reactive reagents, such as the etching and bonding agents now required for silicone polymer bonding. These nontoxic, biocompatible materials at the same time selectively resist surface interactions, forming a nonadherent interface that can serve as a fouling-resistant or fouling-release surface, with reduced drag and altered surface wettability.

Kent will not reveal details of the polymer preparation and structure. KISS is seeking patent protection for the materials. However, the materials are made by modifying crosslinked high-molecular-weight polymers. He has worked mainly with silicones and polyurethanes—both implantable medical grades—but he says the chemical formulations would work as well with polyethers or other high-molecular-weight crosslinked polymers.

What he does is to modify the chemistry of the polymers by "manipulating the prepolymerization process." This affects the way a polymer—for example, a silicone—polymerizes, and results in a different crosslinked configuration than that found in normal silicones (for example, a more methylated surface). This process alters the surface energy, changing surface behavior: For instance, a silicone surface can be made permanently tacky. He also can produce "tethered" surface-bound polymers—a surface-extended network of crosslinked chains with loose ends reaching into, and thereby controlling, flow/adhesion properties in the liquid phase.

The polymers can be readily modified with additives and/or thinners to change their color, consistency, and surface chemistry. The silicone polymer is made as a wax, paint, and jelly. The wax is just wiped on and wiped off, leaving a very thin film.

The first practical application is as a marine coating, which Kent hopes to market under the name "KISS-COTE" (he is seeking trademark approval). Current antifouling coatings act by presenting a toxic surface to marine organisms. By contrast, KISS-COTE presents a nonstick, slippery surface, on which the organisms cannot readily colonize. Thus, coated glass fiber test plates that have been suspended in the Gulf of Mexico for nine and 15 months can easily be wiped clean of barnacles and other growths with a bare finger; uncoated plates cannot be cleaned even by scraping with a sharp knife. Moreover, unlike current coatings, KISS-COTE requires no primers or other pretreatment, even on glass fiber boats.

Kent is also studying other applications. In limited animal trials, a polymer coating reduced sticking of blood cells and bacteria in small-diameter artificial blood vessels. The silicone polymer is permeable to oxygen, and so he is working with a local fence firm to test use as a wood sealant and preservative. Use in surgical dressings is another suggestion. Use in toothpaste and in crown and denture coatings, to prevent sticking of plaque and food, looks promising. And coating airplanes to keep off ice, insects, and other debris is a possibility.

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