LESSONS FROM THE FIELD:
THE VALUE OF INTERDISCIPLINARY RESEARCH
A researcher in Materials Science describes the importance of reading and researching outside standard fields of research - talking about his results of combining materials science, biology and medicine.
Anthony B. Brennan, Ph.D., D.Sc. is a professor of Materials Science and Engineering at the University of Florida, where he leads the Brennan Research Group. But he also has a strong interest in biology and has a joint appointment to the University’s Department of Biomedical Engineering. Much of his research, therefore, lies at the intersection of materials science, biology and medicine.

One of his projects, funded by the Office of Naval Research (ONR), is to find ways to reduce the buildup of algae and marine organisms on ships’ hulls. According to the ONR, a biofilm can increase drag by 20% and barnacles by up to 60%. This buildup reduces vessel speeds by as much 10%, increases fuel usage by 40% and costs the Navy $1 billion annually in fuel and maintenance.

A decade ago, Brennan was looking at algae growth on some test panels at Pearl Harbor, accompanied by botanists and marine biologists from the University of Hawaii (UH). Brennan’s observation that a passing submarine looked like a whale sparked a conversation about which marine animals resisted fouling on their skin. After considering and rejecting whales, porpoises, manatees and sea turtles, the group agreed that nurse sharks remained algae-free, despite those sharks spending much of their time immobile.

“I said that it would be interesting to know what is on their skin,” relates Brennan. “I didn’t know anything about it and neither did the people there, so it got me looking into the field of sharks.”

Brennan’s research was assisted by members of the Materials Science and Biomedical Engineering departments, a chemical engineering student and others. The University of Florida has an extensive shark research program and a repository which includes bone and skin samples of every known species of shark, so Brennan obtained a skin sample, made an impression of the dermal denticles and examined it with scanning electron microscopy. The denticles ribbed, diamond-shaped scales with — a vascular core of dentin encased in an acellular layer similar to the enamel on human teeth — reduce drag and protect against fouling.

Based on the skin samples, Brennan’s team created an artificial film, called Sharklet, composed of diamond-shaped “denticles” that are 26 microns wide and 3 microns deep, which can be applied to surfaces to prevent algal growth without the use of toxic chemicals. While this technology has yet to be applied to ships hulls, we can expect to see it soon in hospitals.

It turns out that one organism that the zoologists at the University of Hawaii’s Kewalo Marine Laboratory, which is also engaged in fouling research for the Navy, use to measure the fouling potential of a surface is a particular type of tube worm. That tube worm requires a bacterial biofilm on the surface before the larvae will land there and attach. Sharklet samples were sent to UH researchers for testing.

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— Anthony B. Brennan Ph.D., D.Sc., Professor of Materials Science and Engineering at the University of Florida
“When we were testing early on some of the Sharklet patterns they weren’t fouling, the larvae weren’t settling,” says Brennan. “So it got me to ask the question if there is any bacteria biofilm on there, and we couldn’t see any.”

Further research determined that the Sharklet surface inhibited a wide range of bacteria, including the Methicillin-resistant Staphylococcus aureus (MRSA) which has been spreading in hospitals due to its resistance to antibiotics. The Sharklet surface doesn’t kill bacteria, but the surface isn’t suitable for the bacteria to reproduce and spread. As a result, there is 90% less bacteria living on the surface.

Brennan and others received a first patent (assigned to the University of Florida Research Foundation, Inc.) covering Sharklet in 2006, with others issued later or pending. In 2007, Brennan and Joe Bagan created a privately-held company, Sharklet Technologies, to develop and license applications for the surface. Catheters account for about 40% of all hospital acquired infections and in March 2011 the National Institutes of Health awarded Sharklet Technologies a $1.2 million grant for development of a Sharklet-patterned catheter. Cook Medical licensed the Sharklet-catheter technology the following year. LGInternational is producing Sharklet films under the Tactivex name which can be applied to surfaces many people touch — such as bathroom doors, countertops and credit card keypads — to reduce spreading of diseases in these areas. In December 2011, Altria Ventures provided $2 million in Series B financing in exchange for a 12.5% stake in the company.

All of this is a far cry from the original work being done for the Navy. Sharklet is still being developed for marine applications, but Brennan says it may be another decade before it is available for that market. It is easier to begin with products the size of a medical device before moving up to a naval vessel. Brennan notes that it is vital to look outside one’s own narrow field of research and to recognize the contributions of other fields that could provide insight into what one is trying to accomplish.

“Be ready to read and to examine outside your field,” advises Brennan. “I have been to invasive species meetings, I speak at yacht clubs and have attended world congresses on every range of nanotechnology, biomimicry and green technologies. There is this huge world of literature in other fields that can impact your own work. You just have to be open to new ideas and meet new people. Go out and seek new ideas.”
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