SurFACTS in Biomaterials

WINTER 2023
VOLUME 28, ISSUE 1

INSIDE THIS **ISSUE**

From President Landon Nash

Welcome to the Winter 2023 edition of the Surfaces in Biomaterials SurFACTS newsletter! As a reminder to our membership, this publication is an opportunity for our membership to showcase their research and technologies to a targeted technical audience. SurFACTS is differentiated from typical white papers because there is less emphasis on the HOW (i.e. methods) and more on the WHAT (i.e. technical attributes). This is an intentional emphasis for our industry membership who may be hesitant to share proprietary details, but still want to advertise their work to their industry peers. To any of our new SurFACTS readers, welcome and thank you for joining. For those that consistently read every edition of our newsletter, thank you for your continued support!

The entire SIBF Board looks forward to seeing everyone at the 2023 BioInterface Workshop and Symposium at the Catamaran Resort in San Diego, Monday 9/25/23 - Wednesday 9/27/23. Please reach out to any of the SIBF Board members if you are interested in being an active participant in the conference.

There are many opportunities to get involved including chairing/co-chairing a session, being a technical presenter, being an exhibitor, or sponsoring any component of the 2023 BioInterface event. You can find more details about these opportunities on our website: www.surfaces.org.

The planning committee is in full swing, and we are actively filling the program for BioInterface 2023. Please keep an eye out for our Call for Abstracts to submit your talk!

The technical program includes:
-Full Day Workshop: Orthopedic Implants
-Keynote Presentation
-Technical Sessions
1. Implantable Sensors
2. Surface Modifications
3. Medical Fabrics and Fibers
4. Navigating the MDR Transition
5. Recombinant and Biomimetic Biomaterials
6. Ophthalmic Devices
7. Engineering the Clotting Cascade
-Point/Counterpoint Session
-SIBF Award Winner Presentation
-Student Competition

On behalf of the Surfaces in Biomaterials Foundation, we look forward to your continued engagement in 2023. Please stay tuned for future SurFACTS newsletters, BioInterface 2023 updates, and other SIBF events.

Internships in Industrial Research

Jason Miranda: Galvani Bioelectronics, SIBF Board Member

This is not our grandparent's internship.

Back in the day, internships got a bad rap for being a rite of passage on the path to a career in industrial research. Interns would go to a company and do hard work for little or no pay but a foot in the door. Now, internships are recognized as providing high value to both the company and the up-and-coming scientists. So many companies are partnering with academia and other businesses that a student has opportunities to be a part of the highly interdisciplinary network of applied science. As an employer, the value of diverse thinking in innovation is at the forefront of how we work. As we support the development of young scientists, we also welcome new ways of approaching complex problems.

As both sides consider entering this partnership, considering the value you offer to each other, and building the experience around that, will create some of the highest returns on investment you'll ever see.

What are employers offering interns?

·Practical experience in industrial research - This is the core of any research experience, and subtle differences in the approach to product focused science can be novel and valuable learning experiences. This often comes with technical training on state-of-the-art techniques.

·Exposure to non-science aspects of research- A patient or consumer focused product development program can include exposure to regulatory, business development, corporate governance and intellectual property functions of the business. This is an opportunity to see and sometimes participate in the wider process.

·Expanding professional network - With the collaborative and interdisciplinary approach many companies take to research, the opportunities for building a broad professional network, often outside the host company, become highly valuable as students wrap up their degrees.

·Increasing future employment value - Entering the job market with some industrial research experience is a real boost, whether you want to join a company or become a professor.

·Pay - Of course, fair market pay is standard, so students earn money while building a career.

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Internships in Industrial Research...

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What are interns offering employers?

- Refreshed innovation – Early career scientists bring a valuable characteristic to the innovation process: inexperience. Highly experienced teams can push projects forward quickly and smoothly when the challenges are familiar. For novel and complex problems, creating a space where the fundamental questions can be asked, such as "why are we doing the process this way instead of that?", can lead a team to "that's a great question!" moments and drive toward novel solutions.

- New connections to academic labs – Many interns are already doing research in academic labs at their own institutions and can often provide new connections between industry and academic researchers. This enriches the broader scientific field and can lead to new partnerships to drive innovation.

- Small projects can bring big value – Everyone has small projects sitting on their desk that are low priority and low urgency but potentially exciting for the company. These projects are often perfect for an intern to own and develop and can lead to new tools for efficiency or a kickstart to a new important concept for the company. They also add to the intern's development as an independent scientist.

- Develop a rich network outside the company and future employees – After their time at a company, these early career scientists go on to work in a broad range of jobs in patent law, regulatory, clinical research, academia, contract research organizations, marketing and more. Over time, this can greatly increase the depth of a company's network in their sector and, who knows, maybe even their next superstar hire.

Electrospun Scaffolds with Rhamnolipids to Treat Depleted-Uranium Contaminated Wounds

Brenda Padilla,[1,2] *Marjorie A. Nguyen,*[1,2] *Taylor R. Gilmore,*[1,2] *Chett J. Boxley,*[3] *Jeanne E. Pemberton,*[4] *and Robert S. Kellar*[1,2]

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Depleted uranium (DU) is a metal by-product produced after the enrichment of natural uranium to lower its radioactivity for military use. Although most of the radioactive isotopes have decayed, DU remains both toxic and a radioactive health hazard when ingested or inhaled into the body (Briner, 2010). Internal uranium toxicity has been shown to increase the risk of lung cancer, kidney disease, and nephrotoxicity (Shaki, 2019). Currently, over 500 abandoned uranium mines in the American Southwest pose a threat to the surrounding environment and to the population’s health through the ingestion of contaminated water (Hoover, 2017).

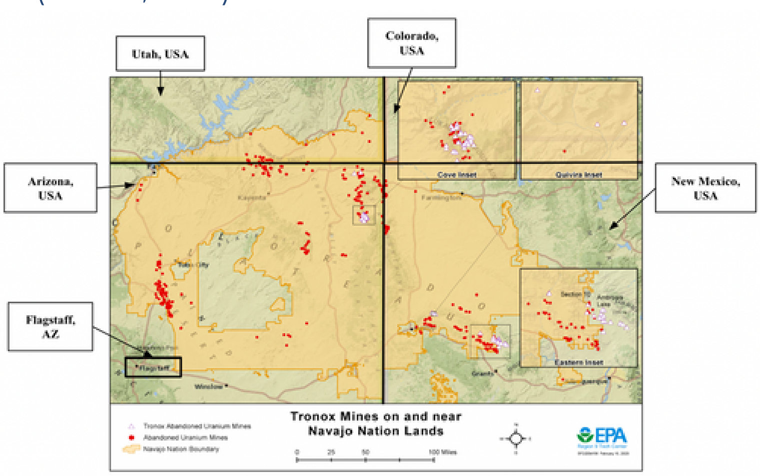

Figure 1. Map overview of the 523 abandoned mine sites across the Navajo Nation. Uranium leaching from these mine sites has resulted in elevated levels found in water sources. Chronic exposure to uranium can lead to serious health effects, including kidney disease, and lung and bone cancer (EPA 2023).

Limited studies suggest the hindering of wound healing mechanistic events from heavy metal toxicity occurs through decreased cell locomotion (Cruz, 2021) and apoptotic death (Daraie, 2012) in fibroblast cells. Previous publications from our lab demonstrate that exposure to DU has negative effects on the natural wound healing process through a variety of cytotoxic mechanisms such as a decrease in metabolic activity, cell viability, and cell physiology (Cruz, 2021); however, current literature lacks a healing therapeutic to counteract this issue. Several studies show that DU affects mitochondrial function, inflammatory responses, and immune cell content (Shaki, 2019). Therapeutics, such as novel wound coverings, have been developed to promote the wound-healing process by treating wounds with three-dimensional biomaterials made to mimic the extracellular matrix with their nanofibrous structures (Norouzi, 2015). These novel wound-healing devices are often applied to promote cellular migration, adhesion, and proliferation through various mechanisms (Afsharian, 2021), and they may offer convenient delivery systems to incorporate a therapeutic agent into the wound-healing biomaterial.

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Electrospun Scaffolds with Rhamnolipids to Treat Depleted-Uranium Contaminated Wounds

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Recent studies have utilized electrospun scaffolds as antimicrobial agents, skin regeneration stimulants using decellularized tissue, probiotic delivery, and nucleic acid carriers (Afsharian, 2021). Furthermore, we propose that these novel electrospun wound healing scaffolds can be impregnated with unique chemistries to facilitate delivery into the wound bed in an effort to neutralize or de-contaminate the tissue from DU exposure. During initial "proof of concept" studies, an in vitro wound model was prepared using human dermal fibroblasts in combination with a synthetic rhamnolipid, a biodegradable surfactant with known environmental contaminant binding properties.

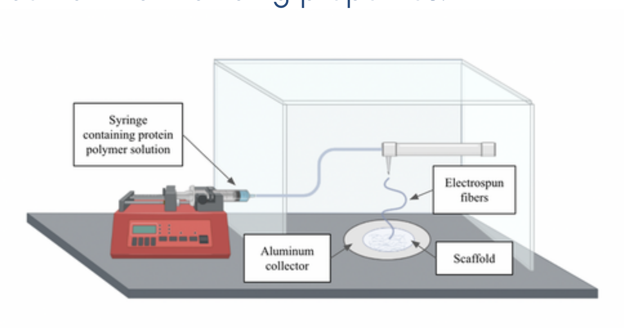

Figure 2. Visual representation of the general process of electrospinning. The polymer protein solution is charged with a high voltage from a positively charged needle onto a negatively charged aluminum collector where nanofibers are encouraged to form.

Using this in vitro wound model, cells exposed to DU and treated with rhamnolipids had an increased percent closure rate over cells only exposed only to DU. These preliminary findings provide "proof of concept" for the continued exploration of using rhamnolipids as a treatment chemistry for DU-contaminated wounds. Secondly, we focused on incorporating rhamnolipids into novel electrospun wound healing scaffolds that have undergone Provisional Patent filing. These rhamnolipids are of particular interest due to their non-toxic nature, antimicrobial properties, and affinity to bind to metals of environmental concern (Asselin, 2014; Rendell, 1990). Impregnation of rhamnolipids in the electrospun devices will be confirmed via 1H nuclear magnetic resonance spectrometry. Cellular biocompatibility of rhamnolipids and fibroblasts was measured using the PrestoBlue and CyQuant direct confirmation assay. The quantitative analysis found skin cells with low to medium treatment concentrations (6.25 µM and 50 µM) had a significant increase in cell metabolic activity, meanwhile, no significant difference between control living DNA content (fibroblast cells without treatment) and the previously mentioned concentrations was found. Integration of fibroblast cells into electrospun scaffolds was qualitatively assessed using scanning electron microscopy.

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Electrospun Scaffolds with Rhamnolipids to Treat Depleted-Uranium Contaminated Wounds

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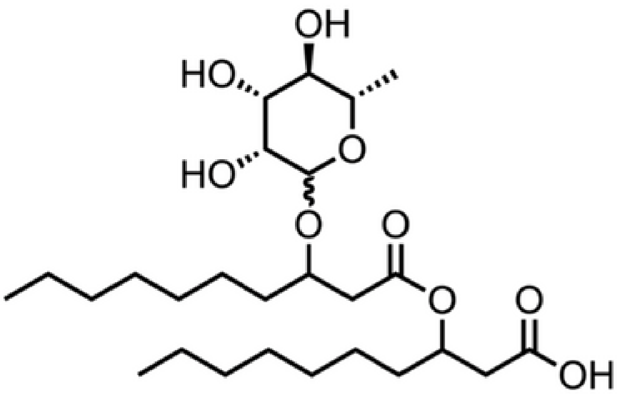

Figure 3. Chemical structure of mono-rhamnolipid (Rha-C10-C10) (adopted from GlycoSurf 2023). Rhamnolipids from GlycoSurf are bio-inspired surfactants produced by eco-friendly synthetic methods, and they are composed of hydrophilic and hydrophobic segments.

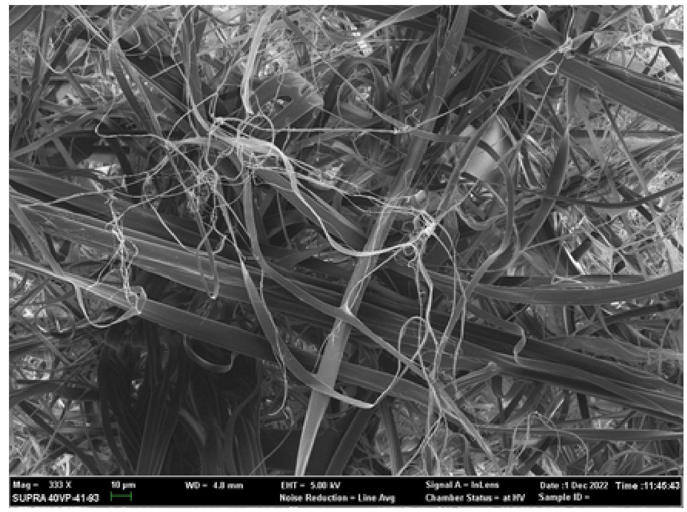

Figure 5. Scanning electron micrograph of bare, (no cells) electrospun scaffold containing 2.5% rhamnolipids.

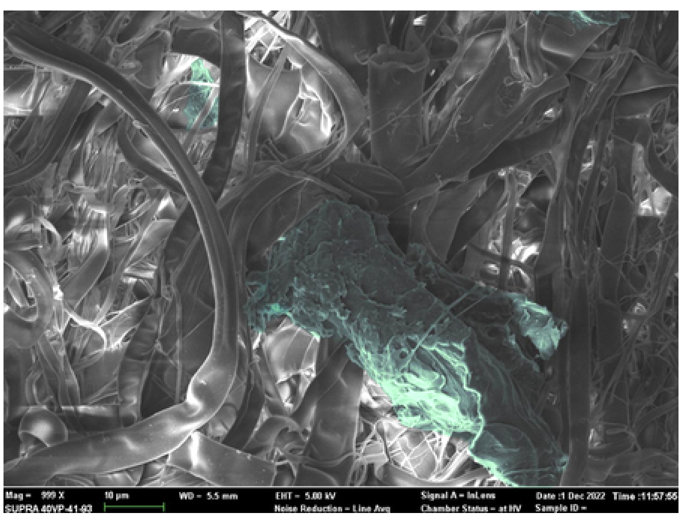

Figure 4. Scanning electron micrograph of a cellularized scaffold containing 2.5% rhamnolipids, demonstrating the impregnated scaffold's cytocompatibility. Human dermal neonatal fibroblast cells (highlighted in green) are shown woven into the scaffold structure.

This study aims to evaluate the properties of rhamnolipid scaffolds and their ability to bind to U, a heavy metal contaminant commonly found in the presence of drinking water in the American southwest. This research is among the first to examine if hDFn cells display cytotoxic effects in the presence of rhamnolipid scaffolds. Future work will focus on utilizing electrospun rhamnolipid scaffolds as a chelator against hDFn cells contaminated with environmentally relevant levels of uranium. We will accomplish these next steps using inductively coupled plasma mass spectrometry to measure DU content between samples placed with and without scaffolds containing rhamnolipids.

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Mentorship Program

Surfaces in Biomaterials is hosting a **mentorship program**. The goal is to build a professional relationship between mentor and mentees. Once matched, mentors and mentees can create a timeline to meet virtually. The goal is to meet twice in the first month and then at least once a month for a total of six months. **Please sign up to start your mentorship.**

SurFACTS in Biomaterials is the official publication of the Foundation and is dedicated to serving industrial engineers, research scientists, and academicians working on the field of biomaterials, biomedial devices, or diagnostic research.

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