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Thank You to Our Members!

From Marketing Director Courtney Kay

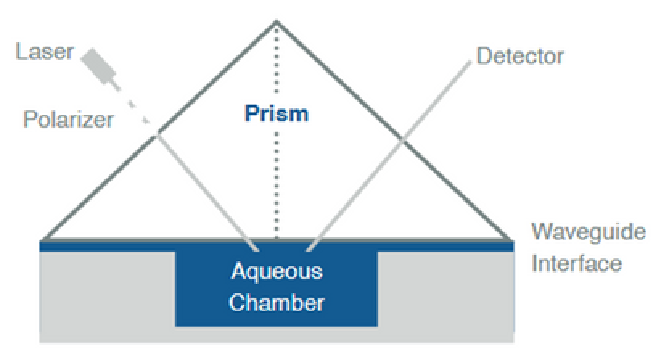
The Surfaces in Biomaterials Foundation brings together a group of passionate individuals focused on developing new technologies in the surface biomedical community. As a raw material supplier it's important we stay active in the community to be at the forefront of new materials, ideas and products. Every year the foundation connects science leaders together for three days to share breakthrough ideas with multiple networking opportunities.

As a member we have an opportunity to shape the BioInterface annual conference sessions by providing input on topics and speakers. There are also opportunities to communicate with key board members daily to develop the vision for the foundation. For the Biointerface conference in San Diego this year I'm excited to support the foundation with 2023 planning and look forward to a successful event!

Plasmon Waveguide Resonance Spectroscopy: Researched by Many, A New Commercial Spectroscopy Offering May Help Increase Your Contribution to Science

Mainline Scientific LLC

PWR (Plasmon Waveguide Resonance) Spectroscopy has been well researched as it provides capabilities not possible with other analytical techniques. Many publications have been written that document the benefits of PWR Spectroscopy, and many research projects have investigated its capabilities. (A full list of eighty plus publications is available upon request.) Up until now, there have been no practical commercial PWR spectrometers. Mainline Scientific will be releasing one, the Emanant PWR Spectroscopy System.



Schematic diagram of the Emanant PWR Spectroscopy System

So what is PWR Spectroscopy? Plasmon Waveguide Resonance Spectroscopy is a kind of optical waveguide spectroscopy, a surface sensitive and label-free analytical tool detecting refractive index change within a few hundred nanometers from the surface (see diagram below). Any event causing refractive index change could be detected. A similar and much more widely used and commercialized technique, Surface Plasmon Resonance (SPR) has been used for decades in studying biological events, such as binding activity of antibody-antigen, protein-DNA interaction, DNA sequencing and others.

A hydrophilic surface in PWR allows for direct investigation of strategically critical events such as membrane-based interactions. Some examples are virus fusion with host cells, G-protein coupled receptor (GPCR) binding activities, single molecule/single cell-based studies, among others. SPR is limited by the intrinsic property of the hydrophobic metal surface. Chemical modification of surface is often needed when studying critical physiological events, i.e. above mentioned GPCR based interactions. Therefore PWR fills a great gap in label free biological events monitoring.

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Also, with PWR spectroscopy, you can analyze using two polarizations of light. The technique allows for both s- polarizations and p-polarizations to be functional, which lets you investigate the anisotropy of the sample layer, observe conformational changes, and gain deeper insight into biological events.

With the mention of SPR Spectroscopy, note that this technique is not intended to replace SPR technology which is in use today. There may be SPR Spectroscopy methods which could also be accomplished more efficiently with PWR Spectroscopy.

Collaboration Program: Mainline Scientific has recently begun a collaboration program. Current collaboration partners include the lab of Uday Kompella at The University of Colorado and the lab of Minying Cai at The University of Arizona. Dr. Kompella's current research is focused on nanomaterials, drug delivery (including collaboration with the foundation's own Dr. Anuj Chauhan at the Colorado School of Mines on drug delivery via contact lenses), nanoparticles, implants and etc.

Dr. Cai is based at The University of Arizona, where she is a research professor and has over 100 publications and numerous patents in the area of novel drug discovery for conditions related to obesity, diabetes, cancer pain and neuro-order disease.

If you are interested in using PWR Spectroscopy to facilitate your contribution to Science please contact us. For a limited number of select participants, we will allow free use, training and support of the instrument in exchange for your feedback and providing agreed upon data that will help us in product development. We are currently in the selection process for participants. To start a discussion visit us at our homepage, scroll to the bottom and select "Contact Us".

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For those attending the SIBF conference in Portland last November, you likely saw us at our first exhibition where we showed off our Emanant PWR Spectroscopy system (photo below). Many thanks to those who stopped by to discuss the system and also to all for the warm welcome. We since then recently exhibited at Pittcon and we are excited by the discussions that we have had with potential collaborators and customers.

About Mainline Scientific: Founded in 2017, Mainline Scientific is a Malvern, Pennsylvania-based bioanalytical technology company. Our team members share an in-depth breadth of knowledge about chemistry, GPCRs, analytical technology, state-of-the-art instrument design, development, and production. For more information you may contact larry.medina@mainlinescientific.com

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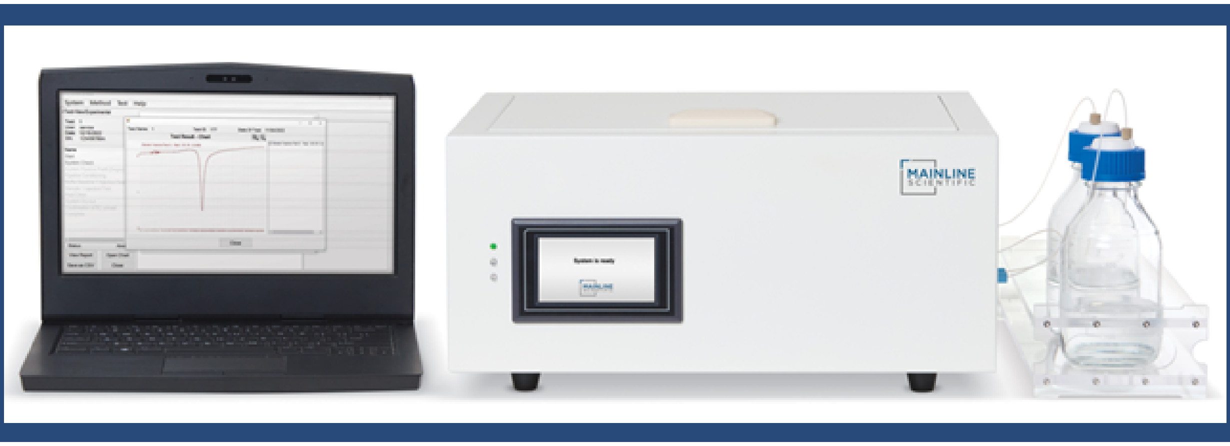

Remote Controlled Milliwheels for the Treatment of Inflammatory Bowel Disease

Matthew J. Osmond,[1,2] *Keith B. Neeves*[1,3]
1 - Department of Bioengineering, University of Colorado Denver | Anschutz Medical Campus, Aurora, CO
2 - Department of Chemical and Biological Engineering, Colorado School of Mines, Golden, CO
3 - Department of Pediatrics, Section of Hematology, Oncology, and Bone Marrow Transplant, University of Colorado Denver | Anschutz Medical Campus, Aurora, CO

Microparticles with controlled drug release are becoming increasingly popular in fighting various ailments. In the case of inflammatory bowel disease (IBD), a chronic inflammation of the intestines, we have developed hydrogel-based microparticles that can be remotely controlled for specific delivery and targeting applications. {Lengyel et al., 2019} These microparticles, which we call milliwheel (m-wheels), satisfy the criteria for treating IBD and offer several other benefits that can be used in other applications for drug delivery to the gastrointestinal tract (Fig. 1).{Osmond et al., 2023}

We wanted to design materials that targets one of the underlying causes of IBD, namely the overexpression of an inflammatory protein called tumor necrosis factor α (TNFα). To do this, we had three criteria that our microparticles needed to have. First, they needed to be biocompatible and not cause more inflammation than already exists. Second, they had to be able to entrain and release common biological factors, such as an antibody targeting TNFα, for a week or more. Third, they needed to respond to remote actuation for specific delivery and targeting applications.

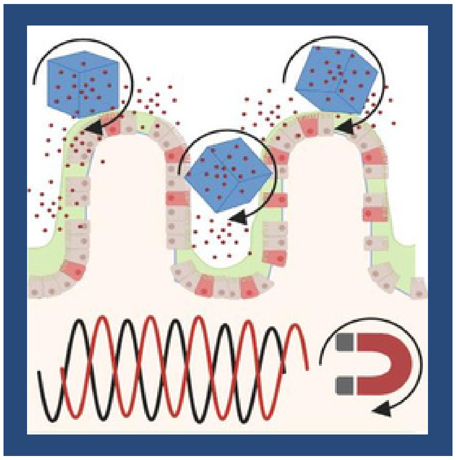

Figure 1. Schematic of milliwheel (m-wheel) drug delivery to the inflamed gut. Milliwheel particles are loaded with drug (red dots) and roll at high speeds along the lumen of the gut by the torque induced by rotating external magnetic fields.

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Remote Controlled Milliwheels for the Treatment of Inflammatory Bowel Disease

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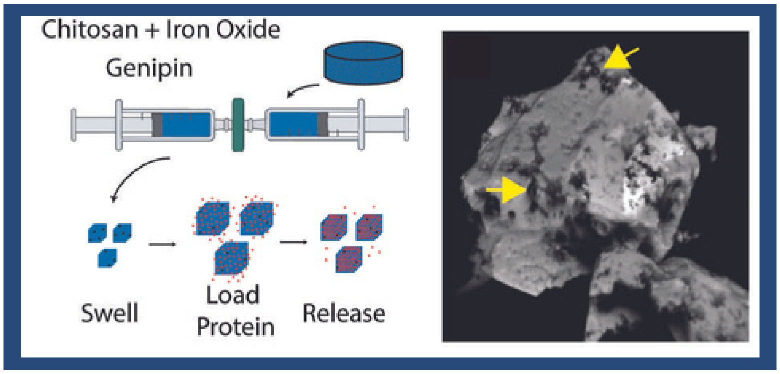

Figure 2. Left: Gelled chitosan, iron oxide and genipin are extruded through 100 mesh screen between two syringes. These microparticles are then loaded with biological agents by swelling and deswelling the matrix around them. Right: 3D reconstruction of a single particle. Yellow arrows point to iron oxide.

Using these criteria, we used hydrogel-based microparticles containing iron oxide powder to form m-wheels. Chitosan, a biocompatible polymer, was used to create a magnetically responsive hydrogel. The bulk gel was then passed through a mesh screen to produce semi-regularly sized magnetic hydrogel particles (Fig. 2). The pH-responsive properties of chitosan were used to swell the chitosan, load it with our biological agent, and de-swell it to entrap it within the hydrogel.

To measure the release capabilities of the m-wheels, we loaded them with a function blocking anti-TNFα antibody and quantified the release rate for a week. We found that higher crosslinking slowed the release rate, while lower pH caused premature swelling and increased the release rate. The release rate can be easily adjusted by changing the loading and crosslinking amounts.

To control the m-wheels remotely, we used five copper coils to generate a rotating magnetic field using amplified alternating current. When the m-wheels are placed within the apparatus, they spin in the same direction as the rotating magnetic field. Friction between the m-wheels and the surface causes them to roll. Importantly, the magnitude of the magnetic field is small (˜ 1 mT) compared to those used for imaging (˜1 T), which is easily scalable up to human dimensions. We showed that m-wheels can easily roll on hard surfaces like glass and soft, viscous surfaces like mucus secreting cells (Fig. 3). At an average speed of 500 μm/s, these m-wheels could roll the 3.5 m distance of the gut in just under 2 hr compared to the 20-30 hr transit time by peristalsis.

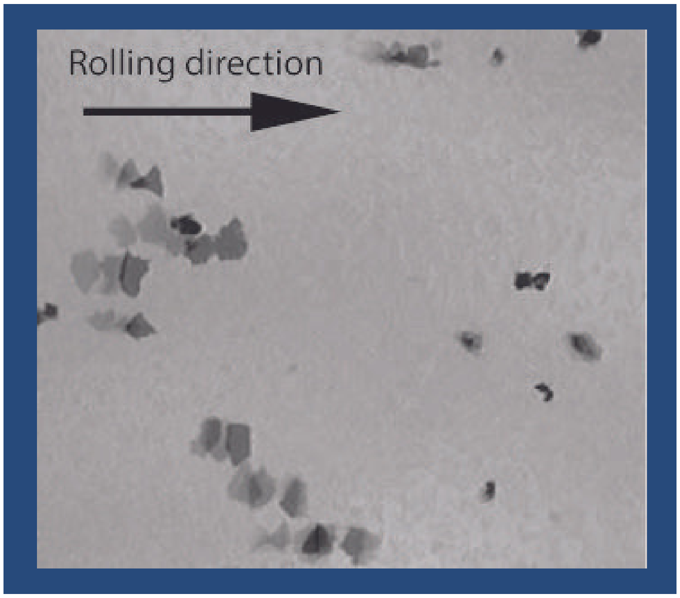

Figure 3. Magnetically powered m-wheel rolling along the surface of model gut epithelial cells in response to rotating magnetic fields.

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We grew cells that mimic intestinal epithelial barrier on membranes treated with TNF and checked how easily things could pass through them, as well as their shape. We then tested conditions where we added m-wheels that either released anti-TNFα or didn't release anything at all. We found that the m-wheels helped to reduce the permeability of the cells in a similar way to anti-TNFα alone. We believe that the m-wheels did this by creating a barrier that slowed down the movement of things through the cells, and by reducing the impact of TNF, which is similar to how the natural mucus layer works in healthy cells. This barrier created by the m-wheels could also help prevent harmful bacteria from entering the cells.

Based on our design criteria, we were successful in moving towards treating IBD. However, we also discovered several other general achievements that can be used in other applications or with other materials. The m-wheels can be made with any FDA-approved hydrogel polymer and the introduction of novel, remote, magnetic actuation seems to be a tool that is underutilized for getting microparticles to hard to reach or delicate regions of the body.

Overall, our development of m-wheels represents an exciting step towards creating targeted drug delivery systems for the treatment of inflammatory bowel disease. Our results demonstrate the potential of hydrogel-based microparticles for controlled drug release and the innovative use of magnetic fields for remote actuation.

Furthermore, the modular nature of our system allows for easy substitution of hydrogel materials, and the scalability of bulk gelation and fractionation suggests that our approach could be readily applied in an industrial setting. As we continue to explore the capabilities of these materials and techniques, we anticipate new possibilities for the targeted delivery of drugs to specific regions of the body, offering new hope for treating a range of diseases and improving patient outcomes.

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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.**

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Professionally Managed by Impact Association Management
1502 W Broadway
Suite 102
Madison, WI 53713
Email: info@surfaces.org
Phone: 612-351-2365

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