Volume 31 Issue 1: 2022 Winter 2022

# Vibrations

Powering Sound Ideas

## Modeling of ultrasonic welding of plastics and 3D printing consolidation: Virtual Collaborations - February 28, 2022

The sixth UIA **Virtual Collaboration** will be held on Monday, 28 February 28 at 10 am EST / 3 pm GMT. ***Please note this day of the week.***

Lokesh Karthik Narayanan, Assistant Professor, Industrial & Manufacturing Engineering, North Dakota State University, will be presenting.

As a researcher, Dr. Narayanan's interests center on development of scalable 3D biofabrication processes that enable manufacturing of engineered tissues. Through his research, he is addressing the issues that hinder the translation of processes to the industry such as scalability and quality control.

**Group Registrations are available**

**Register Now**


### Special Points of Interest



Small group discussions will give participants the opportunity to share ideas with their colleagues and peers about the information presented and specific applications.

## UIA50: 25 - 27 April 2022 will be Multi-Access

UIA50 will be held both in person at Warwick University, UK **and** will have live streaming for extended session so that ultrasonic specialists from around the world will be able to join. Andrew Feeley, chair, is putting together an excellent program.

The costs for either joining UIA live in Warwick or virtually will be the same.

### Call for Papers

**Medical Applications**

**Industrial**

**Workshop**

**Posters**

**presentations due**

**18 February 2022**

**CLICK HERE**

Our format will include 25 minute presentations on the latest in industrial applications on Monday and medical applications to be presented Wednesday.

Tuesday will feature workshops on ultrasonic basics, poster sessions, a tour of Warwick University ultrasonic laboratories and dinner at the Warwick Castle.

Accommodations are available at Warwick University.

**Click here to register for UIA50.**

**Click here to make your hotel reservation at Warwick University.**

# Misonix Acquired by BIOVENTUS® Inc.

On October 29, 2021, MISONIX® Inc., one the longest standing members of the UIA and a leader in the field of ultrasonic therapeutic devices, was acquired by BIOVENTUS® Inc., a global leader in innovations for active healing that include offerings for pain treatment, restorative therapies, and surgical solutions.

Founded in 1959 as Heat Systems, the company's first involvement with ultrasound was as a distributor of ultrasonic cleaners and sonifiers. In early '80s, the first homegrown line of ultrasonic products was marketed under the SONICATOR brand name.

The initial public offering dating back to 1992 was concurrent with the commitment to develop a platform of ultrasonic therapeutic medical devices. "Heat Systems" became "MedSonic Inc." and subsequently, "Misonix Inc."

The Alliger Ultrasonic Wire System was the first application of company's homegrown ultrasonic technology to a specific user need: the treatment of fully occluded lesions located in the peripheral arteries. The technology was used in human clinical trials in US and Mexico. Concurrent with the wire system, product development efforts involved two additional applications: the ultrasonic removal of soft tissue in plastic surgery and the transection and coagulation of soft tissue in laparoscopic procedures.

In September 1996, the company launched its first ultrasonic medical device, the ultrasonic soft tissue aspirator, Lysonix 2000. One year later, the company entered into a license agreement with Unites States Surgical Corporation (USSC) which granted USSC world-wide marketing and sales rights to Misonix' ultrasonic technology applied to cutting and coagulating soft tissue. The outcome of joint development efforts was the AutoSonix Ultrasonic Coagulation Device.

Over the past two decades, Misonix has been engaged in the development and successful commercialization of its three main product lines: BoneScalpel®, SONASTAR® and SonicOne®.

The **BoneScalpel®** technology enables high precision, hard tissue cuts. The repetitive impact of a blunt ultrasonic blade against the targeted osseous tissue results in kerfs as thin as 0.5mm and up to 25mm deep. A patented liquid pathway directs the irrigation fluid to the blade-tissue interface, facilitating safe and effective bone transection

The **SONASTAR®** handpieces and probes deliver power in a compact design engineered for effective soft and hard tissue removal, thus facilitating a wide variety of neuro and general surgery procedures.

The **SonicOne®** ultrasonic instruments enable the ultrasonic debridement of wounds. The patent protected SonicOne OR wound debridement kits are the only ones on the market that use aspiration to prevent the formation of aerosolized irrigant and bodily fluids.

The launch of the **nexus®** Ultrasonic Surgical Aspirator System in 2019 marked the point at which all BoneScalpel, Sonastar, and SonicOne handpieces and instrument kits could be used while connected to a single, high performance ultrasonic console. The nexus product development team was tasked to develop the most versatile ultrasonic therapeutic system in the world, based on a thorough identification of user needs, starting with the most important, our patients, followed by surgeons, OR staff and hospital administrators. The outcome of a fast-paced, two-year development process was a high performance, intuitive, user friendly, upgradeable, compact envelope console driven by a proprietary digital algorithm, compatible with the upgraded neXus handpieces and all, previously developed surgical instruments, packaged in fully redesigned sterile kits.

As a result of the BIOVENTUS acquisition, the MISONIX ultrasonic products have become part of the company's Restorative Therapies and Surgical Solutions verticals in the select company of the **EXOGEN®** Ultrasound Bone Healing System. The combined ultrasound technology expertise lays the foundation for the development and commercial release of future innovative products focused on creating value for patients.

**UIA Bronze Sponsor**

# UIA50 Featured Medical Session Speaker & Abstract

**Dr Helen Elizabeth Mulvana** holds a Chancellor's Fellowship (Senior Lecturer) in Biomedical Engineering at the University of Strathclyde (UofS) and is Research Director for the department. Her multi-disciplinary research is focussed on tissue characterisation and the development of ultrasound imaging for earlier disease detection, and ultrasound as a tool for therapy. She collaborates closely with engineers, clinicians and life scientists.

Helen is an Associate Editor and former Associate Editor-in-Chief for IEEE Transactions in Ultrasonics Ferroelectrics and Frequency Control (TUFFC), co-Chair of the IEEE International Ultrasonics Symposium Technical Program Committee Medical Ultrasonics Group and Web Editor-in-Chief for IEEE UFFC Society. She founded and chairs the Scottish Ultrasound Group to promote partnership with clinicians, academics and industry and is a Chartered Engineer (IMechE). Research funders include BBSRC, EPSRC, CRUK, Medical Research Scotland and Bowel Cancer UK.

This session will be presented at 3 pm BST / 10 am EDT on Wednesday, April 27 and will be live-streamed to our virtual participants

## Contrast enhanced magneto-motive ultrasound for colorectal cancer detection: pre-clinical development

Bowel cancer is the fourth most common cancer in the UK. Treatment commonly involves major surgery, which although potentially curative, carries the risk of short- and long-term morbidity, including the possibility of stoma formation and consequent impact on quality of life. In some cases, it may be possible to treat patients more conservatively through localised resection, however, critical to this decision-making process is the ability to reliably determine the extent of disease and its potential to spread or metastasise. A key determinant of metastatic potential in colorectal cancer, as well as many other tumour bearing cancers, is the existence of disease in the lymph nodes local to the tumour however there exists no effective method of imaging lymph nodes to determine this involvement.

In this talk I will discuss the pre-clinical research we have undertaken in support of developing contrast enhanced magneto-motive ultrasound (CE-MMUS), a new technique to image colorectal cancer lymph nodes. Our approach aims to unite the benefits of contrast enhanced ultrasound imaging, which has recently been investigated to image lymph nodes, and magnetomotive ultrasound, an emerging technique to delineate lymph nodes based on mechanical response. Work to date includes volumetric assessment of colorectal cancer lymph nodes in a pre-clinical mouse model, finite element simulation to better understand system parameters and first proof of principle of CE-MMUS in a pre-clinical model.

**Registration and hotel information on page 4**

# Industrial Session Keynote Speaker / Registration

**Dmitry G. Eskin** is a professor at Brunel University London/Brunel Centre for Advanced Solidification technology (BCAST). Before joining Brunel in 2011, he worked in the Russian Academy of Sciences (1988-1999) and Delft University of Technology/ Materials innovation institute (1999-2011). Prof Eskin is an internationally recognised leader in the fundamentals of solidification processes and ultrasonic melt processing. He has over 300 papers (H-index 51, more than 10,000 citations) and 7 monographs to his name, including Ultrasonic Treatment of Light Alloy Melts (2015) and Solidification Processing of Metallic Alloys under External Fields (2018). He also has patents on alloy design and ultrasound-assisted casting technology for light alloys. Since 2012 he has led 3 EU and 4 EPSRC projects dedicated to the science and applications of ultrasonic melt processing. He is an editor of Journal of Alloys and Compounds, Ultrasonics Sonochemistry, and subject editor of JOM. Prof Eskin has received TMS Warren Peterson Cast Shop for Aluminum Production Awards (2011, 2013), TMS Aluminum Technology Award (2013) and Mendeleev Medal from TSU (2018).

COMING TO WARWICK?

**Click here to make your hotel reservation at Warwick University.**

**Register Now**

**Registration is now open!**

The cost of registration has been lowered from UIA49 in Toronto (2019).

The cost for live participation and virtual is the same - this will cover the cost of the live streaming of the sessions from 8:30 am to 1 pm EDT.

**The registration cost prior to March 1 is:**

**Members - $599**

**Nonmembers - $799**

**Students - $299**

**Poster Presenters - $99**

Registration fees for members and non-members will increase by $100 effective on 1 March.

UIA is pleased to underwrite student participation as a full symposium participant OR as a poster presenter. Students submitting posters have the choice of adding either the Monday Industrial Sessions or the Wednesday Medical Sessions at no additional charge.

# Ultrasound Applications in the News

## New research sheds light on how ultrasound could be used to treat psychiatric disorders

*Imagine passing an exam, and thinking your success was down to the socks you wore or the number of biscuits you'd eaten, rather than the hours of study you'd put in.*

This is issue of 'credit assignment', where a person or animal attributes the wrong outcome to an event, exists in a variety of psychiatric disorders, like addiction or OCD where people still believe that drug consumption on engaging in certain rituals will lead to positive outcomes.

Now a new study in macaque monkeys has shed light on which parts of the brain support credit assignment processes and, for the first time, how low-intensity transcranial ultrasound stimulation (TUS) can modulate both brain activity and behaviours related to these credit assignment processes.

While currently developed in an animal model, this line of research and the use of TUS could one day be applied to clinical research to tackle psychiatric conditions where maladaptive decisions are observed.

Led by the University of Plymouth and published in the journal Science Advances, the study shows that credit assignment-related activity in the lateral prefrontal area of the brain, which supports adaptive behaviours, can be safely and quickly disrupted with TUS.

After stimulating this brain area, the animals in the study became more exploratory in their decisions. As a consequence of the ultrasound neuromodulation, behaviour was no longer guided by choice value -- meaning that they could not understand that some choices would cause better outcomes -- and decision-making was less adaptive in the task.

***"The brain is like a mosaic -- there are multiple parts doing different things. Each part may be linked to a certain behaviour.***

The study also showed that this process remained intact if another brain region (also part of the prefrontal cortex) was stimulated; showing for the first time how task-related brain modulation is specific to stimulation of areas that mediate a certain cognitive process.

The work was co-led by the Wellcome Centre for Integrative Neuroimaging at the University of Oxford, and co-authored by Radboud University, Netherlands; PSL Research University, Paris, France; Pôle Hospitalo-Universitaire, Paris, France; the University of Paris; and the University of Lyon, France.

First author, Dr Elsa Fouragnan -- UKRI Future Leader Fellow at the University of Plymouth -- said: "The brain is like a mosaic -- there are multiple parts doing different things. Each part may be linked to a certain behaviour. The challenge is first to know whether this behaviour is causally linked to a certain brain region. Only brain stimulation allows you to answer this question.

"The second challenge is that if you disrupt or modulate one part, then it can affect several others, so we need to understand how brain areas work together, and how they affect each other if one is stimulated or disrupted.

"The really interesting finding in this study is not only discovering where certain decision making activities take place, but also how neuromodulation can change these and associated behaviours. We hope that this can pave the way to new studies in humans, particularly in patients experiencing mental health issues."

The work is used as a proof of concept study for ongoing research at the University of Plymouth's new Brain Research and Imaging Centre (BRIC), where Dr Fouragnan is the lead of the Non Invasive Brain Stimulation laboratory.

https://www.sciencedaily.com/releases/2021/12/211217102748.htm

*Continued on next page*

# Ultrasound Applications in the News *continued*

## CRISPR/Cas9 gene editing boosts effectiveness of ultrasound cancer therapy

*Sonodynamic therapy uses ultrasound in combination with drugs to release harmful reactive oxygen species (ROS) at the site of a tumor. However, the treatment isn't very effective because cancer cells can activate antioxidant defense systems to counteract it. Now, researchers reporting in ACS Central Science have breached these defenses with CRISPR/Cas9 gene editing, allowing sonodynamic therapy to effectively shrink tumors in a mouse model of liver cancer.*

Hepatocellular carcinoma, the most common form of liver cancer, has a poor prognosis, and surgical treatment by removing part of the liver or transplanting a healthy liver is not suitable for patients with more advanced disease. Because ultrasound can penetrate deep within tissues, sonodynamic therapy could be an effective, non-invasive way to treat hepatocellular carcinoma. But currently, cancer cells can quickly overcome the therapy by activating a gene called nuclear factor erythroid 2-related factor 2 (NFE2L2), which deploys the cells' detoxification and antioxidant enzyme defenses. CRISPR/Cas9 gene-editing technology has been used to knock down gene expression in the lab. So, Wei Feng, Huixiong Xu, Yu Chen and colleagues wondered if they could increase sonodynamic therapy's effectiveness by using this technology to reduce NFE2L2 expression.

As a first step, the researchers encapsulated the CRISPR/Cas9 system and an ROS precursor molecule in lipid nanoparticles. Then, they treated hepatocellular carcinoma cells in a petri dish with the nanoparticles. The lipid nanoparticles were taken up by the cells' lysosomes. Ultrasound treatment caused ROS formation, which ruptured lysosomes and allowed the CRISPR/Cas9 system to enter the nucleus and knock down NFE2L2 gene expression. The ROS also damaged other cellular components. As a result, significantly more cancer cells died from the sonodynamic therapy than without NFE2L2 gene editing.

*Because ultrasound can penetrate deep within tissues, sonodynamic therapy could be an effective, non-invasive way to treat hepatocellular carcinoma.*

Next, the team injected the nanoparticle treatment into mice with implanted human hepatocellular carcinoma tumors. After 15 days of the combined nanoparticle and ultrasound treatment, all of the tumors in the mice disappeared and didn't come back. Mice treated with sonodynamic therapy alone had fewer tumors than untreated mice, but the addition of the CRISPR/Cas9 system significantly improved the therapy's effectiveness. Because gene editing occurs only in tumor tissues under ultrasound irradiation, it won't cause gene mutations in healthy tissues, the researchers say.

https://www.sciencedaily.com/releases/2021/12/211208085956.htm

## The first topological acoustic transistor

*Topological materials move electrons along their surface and edges without any loss, making them promising materials for dissipationless, high-efficiency electronics. Researchers are especially interested in using these materials as transistors, the backbone of all modern electronics. But there's a problem: Transistors switch electronic current on and off, but it's difficult to turn off the dissipationless flow of electrons in topological materials.*

Now, Harvard University researchers have designed and simulated the first topological acoustic transistors -- with sound waves instead of electrons -- and proposed a connection architecture to form a universal logic gate that can switch the flow of sound on and off.

"Since the advent of topological materials around 2007, there has been a lot of interest in developing a topological electronic transistor," said Jenny Hoffman, the Clowes Professor of Science at the Harvard John A. Paulson School of Engineering and Applied Sciences (SEAS) and the Department of Physics. "Although the materials we used won't yield an electronic topological transistor, our general design process applies to both quantum materials and photonic crystals, raising hopes that electronic and optical equivalents may not be far behind."

*Continued on next page*

# Ultrasound Applications in the News *continued*

The research is published in *Physical Review Letters.*
By using acoustic topological insulators, the researchers were able to sidestep the complicated quantum mechanics of electron topological insulators.

"The equations for sound waves are exactly solvable, which allowed us to numerically find just the right combination of materials to design a topological acoustic waveguide that turns on when heated, and off when cooled," said Harris Pirie, a former graduate student in the Department of Physics and first author of the paper.

Pirie is currently a Marie Curie Postdoctoral Fellow at Oxford University.

The researchers used a honeycomb lattice of steel pillars anchored to a high-thermal-expansion plate, sealed in an airtight box. The lattice has slightly larger pillars on one half, and slightly smaller pillars on the other half. These differences in size and spacing of the pillars determine the topology of the lattice, whether sound waves can travel along a designated channel or not. The researchers then designed a second device that converts ultrasound into heat.

The heat expands the pillar lattice and changes the topology of the waveguide. When coupled together, these two devices allow the output of one waveguide to control the state of the next, just as the electrons flowing in a conventional transistor can toggle other transistors.

These acoustic topological switches are scalable, meaning the same design used with ultrasonic frequencies at the centimeter scale could also work at sub-millimeter sizes and frequencies commonly used to transmit surface acoustic waves, which may help to overcome limitations in integrated phononic circuits.

"The control of topologically protected acoustic transport has applications in a number of important fields including efficient acoustic-noise reduction, one-way acoustic propagation, ultrasound imaging, echolocation, acoustic cloaking, and acoustic communications,"

"The control of topologically protected acoustic transport has applications in a number of important fields including efficient acoustic-noise reduction, one-way acoustic propagation, ultrasound imaging, echolocation, acoustic cloaking, and acoustic communications," said Pirie.

These acoustic metamaterials could also be used as a teaching tool.

"Unlike quantum-mechanical systems, acoustic metamaterials are straightforward, tangible, and intuitive. They serve as an accessible entry point to cutting edge topics in condensed matter physics, including topological insulators," said Hoffman.

The team plans to make a public-facing demonstration of these devices that students or museum visitors can touch, toggle, and hear.

The research was co-authored by Harvard undergraduates Shuvom Sadhuka and Radu Andrei, as well as MIT graduate student Jennifer Wang. It was supported in part by the Science and Technology Center for Integrated Quantum Materials under the National Science Foundation grant No. DMR-1231319.

https://www.sciencedaily.com/releases/2022/01/220105111351.htm

## From the President

**Dominick DeAngelis**

**UIA President**

Our "hybrid" UIA50 symposium event in Warwick later this year is really starting to pull together with the selection of these excellent keynote speakers for the medical and industrial sessions. Our eternally dedicated conference chair Andrew Feeney is also hard-at-work soliciting other great presenters to round-out the rest of the program, and arranging a physical tour of the Warwick University ultrasonic laboratories; the physical tour should be the easy part, since it looked so good virtually at last year's conference as presented fabulously by Warwick professor Steve Dixon.

Although there is a virtual component to the symposium, it should be stressed that many board members are making the gallant effort to attend in-person, so I strongly encourage anybody that is on the "fence" to make the physical journey: there is no substitute to being in-person at a famously colloquial UIA event if you have the means and opportunity to attend in-person! They "had me" with "dinner at the Warwick Castle" to say the least. ☺

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## How can ultrasonics enhance the value of your business?

UIA is the international business forum for users, manufacturers, and researchers of ultrasonics. Our members use acoustic vibrations to improve materials, industrial processes, and medical technology. We call this *powering sound ideas.*

Let's work together to power your sound ideas. Contact a member consultant or company through our online Referral Network, learn about ultrasonics with our online primer, or meet industry leaders at our next symposium.

## Important Dates


**18 February 2022: Call for Papers/Posters Submission Deadline**

**28 February 2022: Virtual Collaborations**

**25 - 27 April 2022: UIA50, Warwick University, UK (multi-access: live and virtual)**

**June 2022: Virtual Collaborations**

**September 2022: Virtual Collaborations Mini Symposium**

**November 2022: Virtual Collaborations**