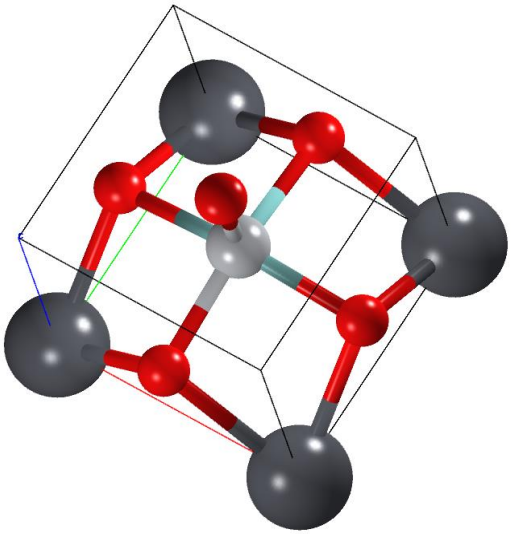
# IRWBM 2022

# 3rd International Research Workshop in Biomechanical Microsystems 2022

Program and Abstracts



October 21st, 2022
Kaunas University of Technology
Lithuania

# IRWBM 2022

## 3rd International Research Workshop in Biomechanical Microsystems

**Organized by:**

**Faculty of Mechanical Engineering and Design**
**Kaunas University of Technology**

# Location

Due to the COVID-19 situation the seminar will be held online via Zoom. Connection for the virtual room is here:
https://liedm.zoom.us/j/4750587436

Please connect 5 minutes before the meeting and test your video and audio devices.

# International Organizing Committee

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|---|---|
| Prof. Giedrius Janušas | Chairman, Kaunas University of Technology, Lithuania |
| Prof. Arvydas Palevičius | Scientific program supervisor, Kaunas University of Technology, Lithuania |
| Prof. Sergei Kruchinin | Member, Bogolyubov Institute for Theoretical Physics, National Ukrainian Academy of Science, Ukraine |
| Prof. Vytautas Ostaševičius | Member, Kaunas University of Technology, Lithuania |
| Dr. Petr Lepsik | Member, Technical University of Liberec, Czech Republic |
| Dr. Kęstutis Pilkauskas | Member, Kaunas University of Technology, Lithuania |
| Dr. Sigita Urbaitė | Coordinator, Kaunas University of Technology, Lithuania |

# Invited speakers

| | |
|---|---|
| **Prof. Kolli Lalit Narayan** | Department of Mechanical Engineering,<br>Sir CRR College of Engineering, India |
| **Sohrab Nasiri** | Department of Mechanical Engineering,<br>Kaunas University of Technology, Lithuania |

# Program

Friday, October 21

| | |
|---|---|
| 09:30-10:00 | **Registration** |
| **Opening Ceremony** | |
| 10:00-10:10 | **Welcome by Prof. Giedrius Janušas**<br>*Chairman of International Research Workshop in Biomechanical Microsystems* |
| **Plenary session** | |
| 10:10-10:30 | *Invited speech*<br>**Design and structural analysis of the car bumper using composite materials**<br>*Kolli Lalit Narayan*<br>Department of Mechanical Engineering, Sir CRR College of Engineering, India |
| 10:30-10:50 | *Invited speech*<br>**Highly porous nanocomposite consisting of Ag/ HA /PVTMS for bioactive-microfluidic applications**<br>*Sohrab Nasiri*<br>Kaunas University of Technology, Kaunas, Lithuania |

| Session | |
|---|---|
| 10:50-11:00 | **Study of mechanical performance of nano-graphite fillers adapted epoxy hybrid composites**<br>*Ayyappa Atmakuri*<br><br>Faculty of Mechanical Engineering and Design, Kaunas University of Technology, Kaunas, Lithuania |
| 11:00-11:10 | **Natural fiber-based hybrid composites and bio-composites and their applications in various fields**<br>*Mostafa Sadeghian*<br><br>Kaunas University of Technology, Kaunas, Lithuania |
| 11:10-11:20 | **Experimental study of the influence of temperature on the mechanical properties of thermoplastics**<br>*Justas Ciganas, Giedrius Janusas*<br><br>Faculty of Mechanical Engineering and Design, Kaunas University of Technology, Kaunas, Lithuania |
| 11:20-11:30 | **Analysis of AAO membranes manufactured by applying vibration in electrochemical reactor**<br>*Urte Cigane, Arvydas Palevicius*<br><br>Faculty of Mechanical Engineering and Design, Kaunas University of Technology, Kaunas, Lithuania |
| 11:30-11:40 | **Spiral dispenser**<br>*Vytenis Naginevicius, Skirmantas Adomavicius*<br><br>Kaunas University of Applied Engineering Sciences, Kaunas, Lithuania |
| 11:40-11:50 | **Resent researches of flexible electronics for automotive industries**<br>*Mantas Mazys, Sigita Urbaite*<br><br>Faculty of Mechanical Engineering and Design, Kaunas University of Technology, Kaunas, Lithuania |

# Design and structural analysis of the car bumper using composite materials

K. Lalit Narayan [a,*], Atmakuri Ayyappa[b]

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**Abstract**

A good design of a car bumper must have optimized weight and must provide safety to passengers. Different countries have different performance standards for bumpers. Under the International safety regulations originally developed as European standards and now adopted by most countries outside North America, a car's safety systems must still function normally after a straight-on pendulum or moving-barrier impact of 4 km/h (2.5 mph) to the front and the rear, and to the front and rear corners of 2.5 km/h (1.6 mph) at 45.5 cm (18 in) above the ground with the vehicle loaded or unloaded. Due to increasing competency now a day's tests are carried out at some higher velocities such as 10 m/s to increase the safety level of the vehicle. Increased safety of vehicle helps to claim for larger insurance amount. Automotive development cycles are getting shorter by the day. With increasing competition in the marketplace, the OEMs and suppliers' main challenge is to come up with time-efficient design solutions. Researchers are trying to improve many existing designs using novel approaches. Many times, there are conflicting performance and cost requirements, this puts additional challenges on R&D units to come up with several alternative design solutions in less time and cost compared to existing designs. These best solutions are best achieved in a CAE environment using some of the modern CAD and FEM tools. Such tools are capable of effecting quick changes in the design within a virtual environment.

**Keywords:** automotive bumper; composite material; 3D modelling; ANSYS; stress analysis; total deformation and modal analysis.

# Highly porous nanocomposite consisting of Ag/ HA /PVTMS for bioactive-microfluidic applications

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**Abstract**

In this study, the physical and mechanical properties of doped silver (Ag) hydroxyapatite (HA) were fabricated by mechanochemical and spark plasma sintering methods (SPS). The influence of the dopant on the phase formation, structural properties, mechanical properties and morphological characteristics was investigated. In addition, as a new approach to fabricate a porous framework with an average size of > 100 microns, the hair band was used as a mold in this case. In addition, the stress-strain compression test of the scaffold was considered, and the maximum value of compressive strength was measured as 15.71 MPa. Considering XRD, TEM, Fourier transform infrared (FTIR), scanning electron microscope (SEM) and energy dispersion X-ray (EDAX) analysis, the fabricated scaffold was bioactive and the effects of doped Ag- HA and the use of polyvinyltrimethoxysilane (PVTMS) as an additive were desirable. The results showed that the effects of thermal treatment on the composition of Ag and HA were impressive, while no change in transformation was observed at 850$^{o}$C. In addition, PVTMS plays an important role as an additive to prevent decomposition and create open micropores in the framework, which may be useful for increasing bioactive-microfluidic applications.

**Keywords:** hydroxyapatite; nano composite; spark plasma sintering; bioactivity; microfluidic.

# Study of mechanical performance of nano-graphite fillers adapted epoxy hybrid composites

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**Abstract**

The progress of hybrid composite materials in recent years is gaining more and more interest among researchers due to their lightweight, cost-effectiveness, and superior mechanical properties. And the application of hybrid composites is expanded from the automobile sector to flexible electronics and it is not limited to aerospace, marine, and construction sectors. Though there are so many advantages of using hybrid composites there are a few drawbacks as well, such as delamination, poor bonding between reinforcement and matrix material, matrix cracks, fiber shrinkage, and moisture absorption. To overcome these drawbacks an attempt was made in the present research work. In the current study, the hybrid composites were fabricated by using the basalt and glass fiber-reinforced epoxy matrix material. All the composites were fabricated by using the vacuum bag compression technique. To overcome the delamination and poor adhesion properties, the nano graphite filler particles were added to the composite material through the resin transfer approach. The composites were fabricated by varying the filler material percentage for comparison and to evaluate the impact on composite material. Also, the composites were allowed for pre-heat and post-heat treatment processes to eliminate the excess moisture and to improve the reinforcement and matrix bonding. The Developed samples were allowed for mechanical properties analysis. The results stated that hybrid composites with 10% filler material showed superior mechanical properties over the other composites. Also, the presence of filler material leads to overcoming the fiber shrinkage during testing and moisture absorption was less among the hybrid composites. Hence these hybrid composites with nanofiller material are a potential replacement for conventional materials in automotive industrial applications, flexible electronics, microfluidics, and marine applications.

**Keywords:** hybrid composites; nano fillers; epoxy resin; mechanical properties; moisture absorption.

# Natural fiber-based hybrid composites and bio-composites and their applications in various fields

Mostafa Sadeghian

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**Abstract**
Ecological and eco-friendly concerns and an aspiration to adapt to novel concepts including the green industrial revolution, attract many researchers to evaluate natural fiber-based composites. In this paper, a review of various natural fiber-based hybrid composites and bio-composites is conducted. Moreover, the mechanical and physio-chemical properties of natural fibers are briefly discussed. To forecast and interpret the mechanical behavior of composite/hybrid materials, several models, namely Voigt, rule of hybrid mixtures, Halpin-Tsai model and etc, are summarized. Finally, the natural fiber composites applications in various fields such as biomedical, automobiles, construction, marine, and aerospace industries as well as their future potential are mentioned. Natural fiber-based composites have a great potential to substitute former composites due to their, lightness, low cost, and ecological merits.

**Keywords:** natural fiber-based composites; mechanical and physio-chemical characteristics; modelling approaches; applications.

# Experimental study of the influence of temperature on the mechanical properties of thermoplastics

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**Abstract**

This article is intended to introduce the characteristics of styrene-acrylonitrile (SAN), polyethylene terephthalate glycol (PETG), polyvinyl chloride (PVC) and polylactic acid (PLA) materials. These materials are thermoplastic, so their mechanical properties change as the temperature are changing. Therefore, the temperature dependence of tensile stress and Young's modulus is analyzed in this study. For the experiment, an Instron E10000 equipped with a heating chamber was used to investigate the material properties as a function of temperature. Through experiments and calculations, the stress-strain curves and Young's modulus of different thermoplastics were found. The properties of thermoplastics started to change internally after the glass transition temperature. PETG plastic had the highest glass transition temperature, so its mechanical properties changed the least at higher temperatures. The lowest temperature influenced the mechanical properties of PVC plastic. It was observed that SAN plastic is brittle until it reaches the glass transition temperature. However, PP thermoplastic stood out from all the others due to its high elasticity at low temperatures. The resulting dependencies are further used in finite element analysis to optimize and predict the behavior of materials under certain conditions.

**Keywords**: thermoplastics; material properties; stress-strain curves; Young's modulus.

# Analysis of AAO membranes manufactured by applying vibration in electrochemical reactor

Urte Cigane[a,*], Arvydas Palevicius[b]

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**Abstract**
The high surface area, hardness, nanosized pore structure, ease of pore geometry control, and low production cost are the properties that make nanoporous anodic aluminium oxide (AAO) widely used in various applications such as filtration, bio- and chemical sensors, separation of nanoparticles, supply of medicines, etc. Currently, another important area for scientists is template synthesis, which can use AAO as a nanostructure template. The AAO pore geometry can be controlled by controlling different anodization parameters, such as the electrolyte concentration, anodization time, voltage, temperature, etc. Unfortunately, the influence of vibration on the pore geometry has not been investigated yet. Therefore, this study presents an analysis of AAO membrane produced by applying vibrations during the two-step anodization process. For the use of vibrations during the synthesis, it was important to develop an electrochemical reactor that would be suitable for the synthesis of new nanoporous membranes. The designed reactor was equipped with a vibrating element, a stirring device, and a Peltier element. Theoretical and experimental studies of vibrations were carried out. The results showed that the aluminium plate installed in the reactor can achieve five vibration modes in the frequency range of 3.0 – 9.1 kHz.

**Keywords:** anodic aluminium oxide; nanoporous membrane; vibration; electrochemical reactor; anodization process.

# Spiral dispenser

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**Abstract**
The main purpose of the article is the study of the mechanical characteristics of the spiral in the dispenser element. A spiral dispenser is used to form doses of viscous liquids by imparting a linear motion to the spiral in an axial direction perpendicular to the surface of the spiral at various speeds proportional to the dose sizes. A dynamic model of the movement of the spiral in the cylinder of the dispenser was formed, the attribution of the movement of the spiral was determined, and an experiment was done. An overview of the design features and principles of operation of the dispenser is provided.

**Keywords:** spiral; fluid dosing; attribution of movement; dynamic model.

# Resent researches of flexible electronics for automotive industries

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**Abstract**
Flexible electronics – electronic devices that are not vulnerable to damage and do not lose functionality when bent or stretched. Compared to conventional electronics, the latter are manufactured on rigid printed circuit boards, whereas flexible electronics can be manufactured on plastic or metal foil, which allows the device to be folded or rolled up without altering the device's properties.
The applications are almost identical to, and sometimes even surpass, those of conventional electronics, for example: flexible electronics can be used in the manufacture of automotive circuit boards and membrane switches. Due to its potential applications, flexible electronics is also being implemented in the military industry, from which this type of electronics has a lot of potential and deserves attention.
Design of flexible electronics for automotive industry will be presented and analyzed. Investigations of mechanical and physical properties of the flexible electronics circuit board manufactured twenty years ago, allowed to design a novel prototype of the same circuit just with much better properties, sensitivity and quality, used for the back and front light control in automobiles.

**Keywords:** flexible electronics; circuit; mechanical properties; surface tension.

# Notes