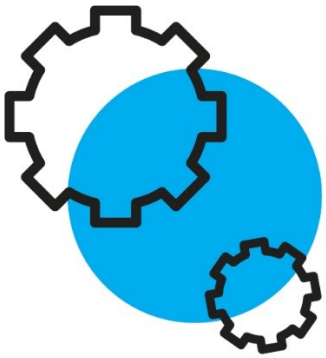

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Book of Abstracts

July 2nd – 3rd, 2020

Online Edition

Content

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Program Overview

PROGRAM OVERVIEW

Online edition of the 7th ICMMEN 2020 International Conference

(Greece time zone)

Thursday , July 2nd, 2020				
10^{00}-10^{10}	***OPENING CEREMONY,* WELCOME ADDRESSES**			
10^{10}-10^{40}	***PLEN1: K.D. Bouzakis:*** "Advanced methods facilitating the prediction of coated tools' cutting performance in milling considering entry impact loads' duration"			
10^{40}-11^{10}	***PLEN2: G.T. Virgil:*** "Complementary methods of profiling the tools that generate by enwrapping"			
11^{10}-11^{40}	***PLEN3: P.J. Bartolo:*** "New trends on additive manufacturing"			
11^{40}-12^{00}	**Break**			
	ROOM A Chairman: P. Kyratsis Presentations Coordinator: G. Mansour		**ROOM B** Chairman: M. Placzek Presentations Coordinator: G. Skordaris	
12^{00}-12^{20}	SESSION 1	**An Ad Hoc Decision Support Method over Additive vs. Conventional Manufacturing** *Stamatios Polydoras, Clio Vossou and Dimitrios Koulocheris*	SESSION 2	**Effect of the crystallinity of NCD and MLD diamond coatings characterized by same level of residual stresses after annealing on their fatigue strength and wear behavior in milling** *Georgios Skordaris, Tilemachos Kotsanis, Apostolos Boumpakis and Fani Stergioudi*
12^{20}-12^{40}		**Experimental Analysis and Soft Computing Modeling of Abrasive Waterjet Milling of Steel Workpieces** *Panagiotis Karmiris-Obratański, Nikolaos Karkalos, Anastasios Tzotzis, Panagiotis Kyratsis and Angelos Markopoulos*		**Influence of stiffness characteristics of a railway track on output parameters in a multibody model** (video presentation) *Ján Dižo and Miroslav Blatnický*
12^{40}-13^{00}		**Optimization of a novel external fixator for orthopedic applications** *Mohammed Alqahtani*		**The Influence of the AWJM Working Parameters on Manufactured Surfaces Microgeometry** *Iulian Patirnac, Razvan George Ripeanu and Eugen Laudacescu*
13^{00}-13^{20}		**A CPS platform oriented for Quality Assessment in welding** *Panagiotis Stavropoulos, Alexios Papacharalampopoulos and Kyriakos Sabatakakis*		**The Study of a Control Signal's Phase Shift Influence on the Efficiency of a System for Active Vibration Damping Based on MFC Piezoelectric Transducers** *Marek Płaczek*
13^{20}-14^{30}	**Break**			
	ROOM A Chairman: K. Salonitis Presentations Coordinator: D. Tzetzis		**ROOM B** Chairman: M. Banica Presentations Coordinator: A. Tsagaris	
14^{30}-14^{50}	SESSION 3	**The mechanical performance of 3D printed hierarchical honeycombs using carbon fiber and carbon nanotube reinforced acrylonitrile butadiene styrene filaments** *Michel Theodor Mansour, Konstantinos Tsongas and Dimitrios Tzetzis*	SESSION 4	**A novel printing channel design for multi-material extrusion additive manufacturing** *Pinar Urhal*
14^{50}-15^{10}		**Vibration isolation performance of an elevator motor using Nitrile-Butadiene Rubber /Multi-Walled**		**Computer modelling and simulation of a novel printing head for complex tissue engineering constructs** *Gokhan Ates*

		Carbon Nanotube composite machine mounts *Konstantinos Tsongas and Gabriel Mansour*		
15^{10}-15^{30}		**Starch Sandstones in Building Bio-materials** *Gabriel Mansour, Maria Zoumaki and Dimitrios Tzetzis*		**An AM-oriented vehicle chassis' A-Pillar Design Approach** *Agisilaos Kyriazis, Stamatios Polydoras, Clio Vossou and Dimitrios Koulocheris*
15^{30}-15^{50}		**Electrospun PCL-Surgihoney meshes for skin wound healing applications** *Enes Aslan*		**Experimental study on noise reduction and performance enhancement for internal combustion engines** *Ioan Radu Şugar and Mihai Banica*
15^{50}-16^{10}		**Impact of process parameters on dimensional accuracy of PolyJet 3D printed parts using grey Taguchi method** *Kyriaki Evangelia Aslani, Apostolos Korlos, John Kechagias and Konstantinos Salonitis*		**Experimental Researches to Establish the Optimum Hardbanding Technology and Materials of the Heavy Weight Drill Pipe** *Mihaela Madalina Caltaru, Razvan George Ripeanu, Marius Badicioiu and Dragos Gabriel Zisopol*
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	ROOM A Chairman: A. Antoniadis Presentations Coordinator: G. Andreadis		**ROOM B** Chairman: A. Wróbel Presentations Coordinator: N. Michailidis	
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17^{10}-17^{30}		**Modeling And Simulation Of The Nanosecond Pulsed Laser Engraving Process** *Evangelos Nikolidakis and Aristomenis Antoniadis*		**Tribological Characterization of Some Elastomers Used at Progressive Cavity and Piston Pumps** *Mhd. Iylad Al Naboulsi, Niculae Napoleon Antonescu, Alin Dinita and Marius Morosanu*
17^{30}-17^{50}		**A Space-Time POD Basis Interpolation on Grassmann Manifolds for Parametric Simulations of Rigid-Viscoplastic FEM** *Orestis Friderikos, Marc Olive, Emmanuel Baranger, Dimitrios Sagris and Constantine N. David*		**Effect of machine hammer peening on the surface integrity of a ZnAl-based corrosion protective coating** *Alina Timmermann, Mohamed Abdulgader, Leif Hagen, Alexander Koch, Philipp Wittke, Dirk Biermann, Wolfgang Tillmann and Frank Walther*
17^{50}-18^{10}		**Prospective analysis of the impact of a pandemic in Industry 4.0** *Ana Isabel Quirós Gámez and Georgios Andreadis*		**Aluminum gas atomization through a Venturi nozzle** *Michail Tsirlis and Nikolaos Michailidis*
18^{10}-18^{30}		**Non-destructive testing of welded fatigue specimens** *Sofia Papanikolaou, Dimitrios Fasnakis, Andreas Maropoulos, Dimitrios Giagopoulos, Stergios Maropoulos and Theodoros Theodoulidis*		**Growth of hydrophobic membrane on copper surface and study of its corrosive behavior** *Fani Stergioudi, Aikaterini Baxevani, Azarias Mavropoulos and Nikolaos Michailidis*

Friday , July 3rd, 2020

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10^{40}-11^{00}		**Design of Multiple Mailboxes** *Athina Baronos, Odysseus Manoliadis and Aristidis Pavlides*		**Model-based definition capabilities and its impact on industrial productivity** *Emmanouil Varitis, Konstantinos Rinos and Nikolaos Kostis*
11^{00}-11^{20}		**Design of a prototype of an engine mechanism with rotating cylinders** (video presentation) *Miroslav Blatnický and Ján Dižo*		**The influence of chromium as a diffusive additive in the boronizing treatment of AISI 4140 steel on the corrosion resistance of the coating evaluated by Electrochemical Impedance Spectroscopy (EIS)** *Dimitrios Zagkliveris, Azarias Mavropoulos and Efstathios Ntovinos*
11^{20}-11^{40}		**Code development for the implementation of the Part Conditional Scale Feature in 3D CAD software platforms** *Konstantinos Vogiatzis and Georgios Skordaris*		Presentation
11^{40}-12^{00}	**Break**			
		ROOM A Chairman: M. Botsaris Presentations Coordinator: A. Korlos		**ROOM B** Chairman: D. Karalekas Presentations Coordinator: K. Tsongas
12^{00}-12^{20}	SESSION 3	**A Pedagogical Methodology for Introducing CAD Modeling Tools and 3D Printing Technologies to Adult Trainees** *Athanasios Manavis, Maria Chatzikyrkou, Prodromos Minaoglou and Nikolaos Efkolidis*	SESSION 4	**3D Printing Assisted Product Design Addressing Refugees Needs** *Antigoni Panagiotidou and Dimitris Karalekas*
12^{20}-12^{40}		**Usability evaluation of mechatronic system by primary school children** *Maria Chatzikyrkou*		**Design of 3D printed smart material compatible hand prosthesis** *Abdalla Omar and Mohamed Hassan*
12^{40}-13^{00}		**Research, Study, Design and Development of an Artificial Ear Splint Model by Using a 3D Printer** *Athanasios Argyropoulos and Pantelis Botsaris*		**Progress And Recent Trends In Generative Design** *Georgios Eleftherios Stavroulakis and Ioannis Ntintakis*
13^{00}-13^{20}		**Skills Requirements for the 4th Industrial Revolution: The Additive Manufacturing Case** *Panagiotis Stavropoulos, Andreas Lianos, Harry Bikas and Dimitris Mourtzis*		**3D-Printed Composite Bone Bricks For Large Bone Tissue Applications** *Evangelos Daskalakis, Liu Fengyuan, Anil Acar, Edera-Elena Dinea, Andrew*

				Weightman, Glen Cooper, Koc Bahattin, Gordon Blunn and Paulo Bartolo
13^{20}-14^{30}	**Break**			
	ROOM A Chairman: E. Budak Presentations Coordinator: M. Zoumaki		**ROOM B** Chairman: P. Bartolo Presentations Coordinator: M. Mansour	
14^{30}-14^{50}	SESSION 5	**Design and Analysis of a 5 Axis Gantry CNC Machine Tool** *Esra YÜksel, Emre ÖzlÜ, Ahmet Hamdİ Oral, Fulya Tosun, Osman FatİH İĞrek and Erhan Budak*	SESSION 6	**Green Face of Packaging – Sustainability Issues of the Cosmetic Industry Packaging** *Jelena Drobac, Vesna Alivojvodic, Predrag Maksic and Marina Stamenovic*
14^{50}-15^{10}		**Design of a spiral bevel gear acc. to ISO 23509:2006 standards** *Ioannis Tsiafis, Polychronia Mamouri and Kyriakos Kyriakidis*		**Circular Economy Framework for Sustainable Product Design Strategies** *Vesna Alivojvodic, Jelena Drobac, Predrag Maksic and Marina Stamenovic*
15^{10}-15^{30}		**Advanced technologies for shoe sole production** *Tatjana Spahiu, Henrique Almeida, Rita Ascenso, Liliana Vitorino and Anabela Marto*		**Stop Wasting! A Plea for Maintenance** *Felicia Veronica Banciu and Eugen Pamintas*
15^{30}-15^{50}		Presentation		**Preliminary studies on the suitability of PETG for 4D printing applications** *Mohamed Hassan, Abdalla M. Omar, Evangelos Daskalakis, Fengyuan Liu and Paulo Bartolo.*

Abstracts – Plenary Sessions

Keynote Speaker

Advanced methods facilitating the prediction of coated tools' cutting performance in milling considering entry impact loads' duration

K.-D. Bouzakis[1,*]

[1]Professor emeritus of the Aristotle University of Thessaloniki and visiting Professor (DAAD-Langzeitsdozent) of the Turkish German University of Istanbul

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Abstract: Coated tools constitute the majority of the tools applied in material removal processes, rendering the employment of uncoated ones as an exception. A broad growing market of coated cutting tools has been developed for meeting the needs of processing of a wide range of materials, from soft aluminium alloys to the most difficult-to-cut materials at the most extreme cutting conditions. Parallel to the emerging of numerous new workpiece, tool and coating materials, sophisticated coatings' characterization methods have been developed facilitating the coatings' mechanical properties characterization and the cutting performance prediction of coated tools.

In the lecture, a recently developed method for determining stress, strain, strain-rate dependent curves for cemented carbide will be introduced. This has become an established tool for evaluating the mechanical properties of coated tools subjected to impact loads. By means of this method, strain-rate dependent data of a cemented carbide K05 insert were determined and employed to define the developed stress and strain fields occurring in the compound coating-substrate at impact forces of various durations. Based on these data, it was possible to analytically calculate, via FEM supported methods, the occurring maximum strains at various impact loads and times. These maximum values and related fatigue endurance coating strain-rate dependent limits were consequently applied to validate published coating fatigue critical impact forces associated with certain impact times. Furthermore, the stress, strain, strain-rate dependent data of the K05 insert were employed to calculate the developed stress and strain fields induced by cutting loads, inside the carbide and its coating, along the tool flank and rake. As a result, it rendered possible to explain the wear behavior of coated cemented carbide inserts at various milling conditions, based on the calculated data and published rate dependent coating fatigue endurance strains.

Keynote Speaker

Complementary methods of profiling the tools that generate by enwrapping

Virgil Gabriel Teodor[1,*]

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Abstract: The research team from the Department of Manufacturing Engineering of the Faculty of Engineering within the "Dunărea de Jos" University of Galaţi has developed a series of complementary methods for the profiling study of cutting tools that generate by enwrapping, by method of rolling.
These methods can be mainly grouped into two categories: graphical, non-analytical methods, based on the capabilities of graphic design environment such as AutoCAD, CATIA, Solid Edge, etc. and analytical methods.
Among the graphical methods, the most recent is the "Family method of relative generation trajectories", developed in the research grant entitled "Synthesis of algorithms for CAD design of cutting tool profiles, generating complex surfaces, with non-analytical means".
Within this contract, the team also proposed the approach of a method of graphical profiling of rack tools, gear shaped tools or rotary cutters, based on a new method which allows the use of capabilities offered by CATIA, AutoCAD or SolidEdge design software. Applications have been made for profiling the aforementioned tools.
Among the analytical methods, the most recent is the "virtual pole" method that allows the profiling of the same types of cutting tools. The method is very recent, its development being started in 2019.
Said method combines the analytical accuracy of the profiling with a simplified calculation method compared to the established algorithms.
For this method, specific applications have been developed such as: gear rack for machining a shaft with a square section, gear rack for generating involutes profile, rotary cutter for processing the flutes of a ball screw, gear shaped cutter for machining the bore of a bushing with K profile.
The new calculation variant is easier to apply compared to the established methods because it is no longer necessary to explicitly write the relative movements between the tool and the part. However, the method remains rigorously scientifically accurate and its application simplifies the calculation process and eliminates some of the possibilities of errors.

Keynote Speaker

New trends on additive manufacturing

Paulo Jorge Bártolo[1,*]

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Abstract: A lecture about some of the current challenges of additive manufacturing and some of our research activities on the use of additive manufacturing in the tooling, construction, agriculture and medical sectors.

Abstracts- Session 1

Paper ID: SESSION 1- 5

Design of a prototype of an engine mechanism with rotating cylinders

Miroslav Blatnický[1] and Ján Dižo[1,*]

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Abstract: In this article, authors focus on the design and construction of a real prototype of an engine mechanism with rotating cylinders and its using mainly in piston combustion engines. It is assumed, that the normal force of a piston will be completely eliminated, because the swing angle of a connecting rod will equal to zero during the whole working cycle, since the connecting arm of the piston moves just the cylinder axis. It will by allowed by the conceptual design of the mechanism presented in this article. As rotating blocks of cylinders concurrently act as a flywheel, it is proposed, that in this way there is possible to save the mass of additional flywheels. Moreover, liquid cooling system is not necessary, because the rotating cylinders sufficiently transfer heat to ambient air. I addition, the output of torque will be reached without necessity of gear transmission, which results to decreasing of needs of mechanism lubrication. Other advance of the designed mechanism are two outputs. The first output is low-speed and it goes out from rotating cylinders, i. e. from the slider-crank mechanism with revolutions n1. The other output is high-speed, from the crankshaft with revolutions n2. Because of more favourable properties of the mechanism, authors have decided to create a real device to confirm all mentioned advantages of the mechanism by the suitable way.

Keywords: *prototype, engine mechanism, rotating cylinders*

Paper ID: SESSION 1- 48

Optimization of a novel external fixator for orthopaedic applications

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Abstract: The use of external fixation devices is a very common method for the treatment of bone fractures. However, these fixators present some limitations in terms of mobility, significant risk of infection, and induce pain and discomfort. Moreover, they are also not fully customized to suit individual patients. To avoid these limitations, this paper presents a novel patient-specific external fixator developed using reverse engineering, finite element analysis and additive manufacturing. The fixator was designed based on a set of computer tomography (CT) scan images of a patient and optimized considering different thickness values and materials. New lightweight designs were produced through a manual process (regular distribution of circular and hexagonal voids) and topology optimization. Different polymeric materials (Polylactic acid (PLA); Acrylonitrile butadiene styrene (ABS) and Polyamide (PA)) were also considered for the fabrication of these designs. It was found that although both PLA and ABS allow to meet the design requirements, and that the best mechanical properties were obtained with fixators made of PLA. Results also showed that the best results in terms of mechanical performance and weight reduction was obtained with topology optimization.

Keywords: *Bone fracture, Customization, External fixation, Topology optimization*

Paper ID: SESSION 1- 52

An Ad Hoc Decision Support Method over Additive vs. Conventional Manufacturing

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Abstract: The Design Process of a mechanical product, system or component considers numerous, diverse, often correlated or even conflicting factors. Some could be regarded as design requirements, directly related to the desired performance and quality, others are limitations imposed by legislation, standards in effect, methods utilized or given technological boundaries, others have to do with urgency, cost, technical data preparation and preservation, design flexibility and other organizational aspects. A successful design process, on one hand starts from an actual need and concludes beyond an object's life cycle, on the other hand is a sequence of proper decisions on form, geometry, materials, manufacturing methods, quality, reliability and many others. Nowadays, a critical decision for anyone involved in the design and realization of technological objects, especially those of industrial production, is whether the object should be made conventionally or with one of the Additive Manufacturing (AM)/3D Printing methods. Such a decision could occur under pressure from demands of emergency or could be a part of a broader strategy for technological switch within an organization. It is definitely a complex, multi-parametric problem, often of great uncertainty and therefore risk. In either case a simple, fast, yet effective and substantiated method to assist in reaching a secure decision for switching from conventional to AM of industrialized components and objects could prove very useful. This paper, after reviewing recent trends and activity in international AM-related standards, presents and discusses preliminary work of the authors currently under development for an ad hoc decision method to be used upon specific "go-no go" decisions for AM. The method starts by limiting the number of critical decision-influencing factors with a Pareto principle consideration. The most critical factors are then registered and categorized, mainly as factors "pro" and "contra" AM. Different effect grades are attributed to each factor included in the decision and are combined with respective importance/preference/priority weights. An aggregation of a total pro and contra score assists the final decision. The method is tested, demonstrated and discussed with typical examples.

Keywords: *Additive Manufacturing, Design Factors, Decision Support Method, Pareto Principle, Industrial Components*

Paper ID: SESSION 1- 60

A CPS platform oriented for Quality Assessment in welding

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Abstract: The major advantages of spot and seam welding are high speed and adaptability primarily for high-volume and/or high-rate manufacturing. However, this paradigm fails to meet the principles laid down by Industry 4.0 for real-time control towards Zero Defect Manufacturing for each individual product and intuitive technical assistance on the process parameters. In this paper, a Robust Software Platform oriented for a CPS-based Quality Assessment system for Welding is presented based on data derived from IR cameras. Imaging data are preprocessed in real-time and streamed into a module which utilizes Machine Learning algorithms to perform quality assessment. A database enables data archiving and post processing tasks along with an intuitive User Interface which provide visualization capabilities and Decision Support on the welding process parameters. The modules' IoT-based communication is performed with 5C architecture and is in line with Web Services.

Keywords: *welding, quality assessment, CPS*

Paper ID: SESSION 1- 61

Experimental Analysis and Soft Computing Modelling of Abrasive Waterjet Milling of Steel Workpieces

Panagiotis Karmiris-Obratański [1,2], Nikolaos Karkalos[1], Anastasios Tzotzis[3], Panagiotis Kyratsis[4] and Angelos Markopoulos[1,*]

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Abstract: Conventional machining processes such as turning, milling and drilling have long been prominent in the metalworking industry, as they are essential for the construction of a wide range of mechanical components. However, alternative processes, which do not require the use of a cutting tool in order to conduct material removal, such as laser, electrodischarge or abrasive waterjet machining have proven to be sufficiently capable of achieving high efficiency in various cases. In particular, Abrasive Waterjet (AWJ) machining can be regarded as a rather considerable choice for cutting operations, taking into consideration that it involves no heat affected zones, is able to process all material types regardless their hardness and has been used to create a variety of complex features with success. However, this non-conventional technique involves a wide range of process parameters which need to be regulated in order to produce mechanical parts with the desired dimensional accuracy, high surface quality and minimum processing time. In the present work, a comprehensive study on the effect of four process parameters, namely jet traverse speed, stand-off distance, abrasive mass flow rate and jet pressure on the width and depth of machined slots on a steel workpiece is conducted. Abrasive waterjet milling experiments are conducted under different process conditions, with the process parameter values varying in a considerably wide range and afterwards the dimensions of the machined slots are measured using high resolution optical microscopy images and image processing software. The results which are obtained are firstly analyzed with statistical methods in order to determine the effect and the relative importance of each parameter on the produced width and depth of the slots. This analysis is decisive, as it can lead to the efficient regulation of process parameters in order to achieve the desired slot geometry. Finally, these results are used to develop a soft computing predictive model based on Artificial Neural Networks (ANN) which can relate the process parameters with its outcome.

Keywords: *Abrasive Waterjet, Milling, Artificial Neural Networks*

Paper ID: SESSION 1- 65

Code development for the implementation of the Part Conditional Scale Feature in 3D CAD software platforms

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Abstract: Modern manufacturing processes involves the construction of complex geometrical parts with high accuracy. As a consequence, the design of such parts and their further data processing by employing 3D CAD software packages is a time-consumed procedure, often endangering the risk of errors due to the lack of automatically processes. A characteristic case is the scale featuring of a 3D part. In most modern 3D CAD software packages, scale feature is implemented as a multiplication of the transformation matrix to all object 's vertices. Many options are provided by the software used such as the scale could be about an origin or a user define coordinate system, or it could be applied only to one or two axes. However, none has the option to define rules of how the scale feature will be applied to one or more entities. In this work, a code was developed that is adding this functionality to a known 3D CAD software (SOLIDWORKS). In this context, new functions were developed using Microsoft Visual Studio C++ for conducting appropriate calculations. The calculated results were inserted to parts' geometry using SOLIDWORKS A.P.I. (Automatic Program Interface). As a characteristic example, the developed code is applied to holes that lie on a planar face and could consist for example the fixed areas of a construction.

Keywords: *3D-CAD design, scale feature, holes in planar face*

Paper ID: SESSION 1- 73

Design of Multiple Mailboxes

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Abstract: In today's world the design of multiple mailboxes comes to cover the evolution of logistics in delivering mail where the postman is not required to visit every user. In this research the 3D visualization is used for the design of multiple mailboxes for domestic use. It concerns the design of mailboxes in ergonomic building blocks and apartment complexes in 3D design so that they can be easily manufactured. Between the advantages of this design will be rapid production of ready-made products production of prototypes that enables testing at the design stage and reduces the time and the cost of production. The design when done with 3D CAD can be manufactured with modern machine tooling methods. In this paper after an extensive Literature Review the postal multiple mailbox is used as a case study in the use of 3D CAD for 3D printing. A methodology is proposed that enables the examination of prototypes at the design stage according to specifications and allows the manufacturing department of a company to prepare the right tools and begin installing production lines. Conclusively this method gives the advantage of designing the product and supporting the production of scaffolds that can be functionally and ergonomically tested before finalizing the production.

Keywords: *3D CAD, 3D Printing, multiple mailboxes*

Paper ID: SESSION 1-74

The design of mechatronic system for gel electrophoresis

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Abstract: The paper presents the methodology to design and implement a mechatronic system for gel electrophoresis. It describes the steps towards the development of a prototype and presents its functions. The new automated system is characterized by high precision, small size and relatively low cost, thus achieving the introduction of a significant innovation in the area of medical and laboratory measurements.

Keywords: *electrophoresis, mechatronic system, design of systems*

Paper ID: SESSION 1- 85

A microcontroller-based software framework for controlling a mechatronic system

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Abstract: The proposed software framework is presented and an Application Programming Interface (API) is developed based on the Arduino Mega 2560. The API processes external commands that follow the operational logic of a gel electrophoresis device. The API acts as an intermediary layer between the gel electrophoresis mechatronic system's microcontroller and the motors' controllers. The microcontroller enables the basic functionalities of the gel electrophoresis system while the use of 2 axis (X, Z) motor controllers is necessary for controlling the moving parts of the mechatronic system. We control the movement's direction, position, speed, and acceleration. The developed API controls the stepper motors drive axles and the DC motors for opening and closing the drawers and other moving parts of the mechatronic system.

Keywords: *Software architecture, API, Arduino controller, microcontroller*

Abstracts- Session 2

Paper ID: SESSION 2- 3

Effect of the crystallinity of NCD and MLD diamond coatings characterized by same level of residual stresses after annealing on their fatigue strength and wear behavior in milling

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Abstract: Nano-composite (NCD) and multi-layered (MLD) diamond coatings were deposited on cemented carbide tools using hot filament chemical vapour deposition (HFCVD) techniques. Appropriate annealings were conducted on the examined diamond coatings in order to be characterized by the same level of residual stresses. The crystalline structure of the employed diamond coatings was investigated by conducting Raman spectra. Inclined impact tests at ambient and elevated temperatures were carried out for assessing their temperature-dependent fatigue strength. Moreover, the wear behaviour of diamond coated inserts was investigating in milling aluminum foam. Raman spectra were also conducted on the treated diamond coatings for capturing potential crystalline changes developed due to the exercised thermal and dynamic mechanical loads during cutting. According to the attained results, the co-existence of sp2– and sp3-bonded phases in the cases of MLD diamond coatings results in an accelerated wear development, despite their structure capability to decelerate the crack propagation. As a result, nano-crystalline diamond coatings characterized only by sp3-bonded phase exhibit an improved wear behaviour. The cutting performance of the NCD coated inserts is further improved due to the enhanced tribological properties of the NCD coatings.

Keywords: *Diamond coatings, Annealing, Wear*

Paper ID: SESSION 2- 4

Influence of stiffness characteristics of a railway track on output parameters in a multibody model

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Abstract: The article is aimed at the research of the influence of stiffness characteristics included in a model of a railway track, which is the part of a multibody system. The other part of the multibody model is a railway vehicle. Authors are focused on the investigation of response of some selected output parameters under various values of input of stiffness and damping coefficients. The interaction of a railway vehicle and a railway track is studied. A passenger railway vehicle has been chosen for presented research. Outputs parameters are chosen in the passenger ride comfort point of view and the running safety point of view. The passenger ride comfort can be evaluated either by the direct method, when a real vehicle runs on a track and passengers evaluate a vehicle by means of their feelings during the ride or by means of the indirect method, when accelerometers are used for measuring accelerations in various positions of a tested wagon and subsequently values of accelerations are processed in required way. Then, the ride comfort is calculated and indexed by means of ride comfort indices. In the presented work, the indirect method has been used. In the computer multibody model of the wagon accelerations on a floor have been detected and the mean ride comfort for a person is assessed. The ride safety is most often determined by waveforms of vertical wheel forces, lateral wheel forces and the derailment quotient.

Keywords: *multibody model, stiffness characteristics, railway track, railway vehicle*

Paper ID: SESSION 2- 7

The Study of a Control Signal's Phase Shift Influence on the Efficiency of a System for Active Vibration Damping Based on MFC Piezoelectric Transducers

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Abstract: Active vibration damping of mechanical systems based on applications of smart materials has a large application potential and is getting more and more popular. In active vibration systems the fast response of actuators to the signals generated by sensors is one of the most important element that decides of the system's efficiency because the idea is to generate force by active elements that will suppress the vibrations detected by the sensors. In this paper results of laboratory tests of a control signal's phase shift influence on the efficiency of a system for active vibration damping based on application of Macro Fiber Composite (MFC) piezoelectric transducers are presented. MFCs are modern piezoelectric composite transducers produced as a thin, elastic films and can be easily installed on the surface of the mechanical subsystem or laminated in composite structures. The impact of the phase shifting between signals generated to power the actuator on the damping efficiency was verified and analysed. It was verified in what phase angle the damping of vibration has the best efficiency and if the shift of the signals causes the linear loss of the system efficiency. It was also verified whether it causes the same effects in both directions of shifting (advance or delay in the phase of the signal supplying the damper relative to the signal generated by the beam's vibration).

Keywords: *Active vibration damping, Piezoelectric transducers, Sensor, Actuator, Macro Fiber Composite, Laboratory tests*

Paper ID: SESSION 2- 19

The Influence of the AWJM Working Parameters on Manufactured Surfaces Microgeometry

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Abstract: The aim of this paper is to make a research in order to analyze the modification of the microgeometry parameters of AWJ machined surfaces for a ductile material used in oilfield and petrochemical equipment. Experimental research was performed on waterjet cutting machine model YCWJ-380-1520 using pre-establish working conditions. The SURTRONIC 3+ device was used in order to measure the microgeometry characteristics of the machined surfaces. Experimental tests were performed regarding some values for: material thickness, working feed-rate and standoff distance. The obtained outcomes highlighted that there are three zones on cutting surfaces for thick material and only two zones for thin materials. There are a lot of profile parameters provided by the software and there were taken into account only the average roughness (Ra) and average waviness (Wa). For each of those two parameters were accomplished graphical representation for every working parameters in order to establish an analytical dependence between them. The outcomes which were obtained are polynomial four order equations of average roughness and waviness according to standoff distance. The analytical relations obtained give us the possibility to estimate the average roughness of the surfaces related to thickness, feed-rate and standoff distance.

Keywords: *roughness, waterjet, standoff, feed-rate, thickness*

Paper ID: SESSION 2- 23

Functional Analysis Diagram of a Flux Modulated Magnetic Gear

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Abstract: The reliability of a system is generally done by a functional analysis (FA), whose mission is to provide a deep understanding of the object to be designed, to discover all the valuable solutions, modes, and configurations, and finally to choose the best options for the system's design. Functional analysis is then matched with a dysfunctional analysis, such as Failure Modes and Effects Analysis, to foresee and take measures to avoid the possible dysfunctionalities of the system and to determine the most suitable model. In this paper, the functional analysis diagram (FAD) is used in the conceptual phase of the design process of a Flux Modulated Magnetic Gear.

Keywords: *magnetic gear, performances, functional analysis diagram*

Paper ID: SESSION 2- 64

Safety Management of Hazardous Materials -Orphan Radioactive Sources: Contribution of STRASS Project

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Abstract: STRASS project is an INTERREG project, collaboration between Greece and North Macedonia that includes the following aims a) Discovery and identification of radioactive materials (especially orphan radioactive sources and materials that are transferred mainly accidentally) during check in cross border area, b) Location of dangerous points of the roadway Thessaloniki-Skopje. c) Investigation of radiological risk after a traffic accident d) Establishment of common emergency response protocols for both countries. The project deals with circular economy and sustainability and its main challenge that is presented here is to minimize any risk of accident (traffic accident during transportation, dispersion, loss etc) and pollution when handling and transferring willfully or accidentally hazardous radioactive materials.

Keywords: *hazardous materials, radioactive materials, orphan radioactive sources, safety management, risks, sustainability*

Paper ID: SESSION 2- 72

The influence of chromium as a diffusive additive in the boronizing treatment of AISI 4140 steel on the corrosion resistance of the coating evaluated by Electrochemical Impedance Spectroscopy (EIS)

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Abstract: A large variety of protective coating is being used in industrial applications to improve the resistance of the metallic substrates against corrosion. The pack-cementation method for boronizing and borochromizing is effective to produce extremely hard and corrosion resistant thick coatings and, additionally, is a low-cost and simple technique. In the present study, AISI 4140 steel specimens underwent boronizing and afterwards chromizing by the pack-cementation method using B4C as boron source and Fe-Cr as chromium source, respectively. In both treatments the appropriate activators were used. After chromizing the boronized substrate, a mixed boride phase FeCrB was formed, as it was confirmed by X-ray Diffractometry (XRD). The boronized and the borochromized specimens were subjected to Electrochemical Impedance Spectroscopy (EIS). From the analysis of the frequency response of the coating systems (Bode and Nyquist display), the conclusion that the borochromized specimens were significantly more corrosion resistant was extracted. Finally, data of optical and electron microscopy contribute to the validity of the conclusions.

Keywords: *boronizing, boriding, borochromizing, boride coatings, Electrochemical, Impedance Spectroscopy, EIS, X-ray Diffractometry, XRD, Scanning Electron Miscoscopy, SEM, EDS*

Paper ID: SESSION 2- 81

Model-based definition capabilities and its impact on industrial productivity

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Abstract: The need for optimization of the product manufacturing cycle and data management resulted in the creation of the model-based definition technology. The beneficial impact in most processes (CAD, CAE, CAPP, CAM, etc.) of a product manufacturing cycle, made the MBD technology implemented in various industries. The following paper has the purpose of highlighting the benefits and limitations of the current MBD capabilities and makes its impact on the industrial collaboration known by summarizing the communication file formats, which support this technology. Special interest is attributed to lightweight collaboration files, especially 3D PDFs, which are capable to deliver information and data to the domains of a company inside or outside of the manufacturing cycle and support all the necessary downstream activities of the product.

Keywords: *Model-Based Definition (MBD), Model-Based Enterprise (MBE), Product Life-Cycle Management (PLM), Geometric Dimensioning and Tolerancing (GT&T), Product Manufacturing Information (PMI)*

Abstracts- Session 3

Paper ID: SESSION 3- 1

The virtual pole method applied for profiling the gear cutter tool for generating a K-type bore

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Abstract: The "virtual pole" method allows profiling of the cutting tools that generate by rolling. This mode of generation is advantageous in terms of the accuracy of the geometric shape obtained. The mentioned method combines the analytical accuracy of profiling with a simplified calculation mode, compared to the established algorithms. The paper presents an application made on the basis of the "virtual pole" method, for the profiling of the gear shaped tool, designed to generate the bore of a bush with a K-profile. Based on this methodology, in house software was developed for the type of profile mentioned above. The program allows the numerical and graphical representation of the profile to be generated, the contact curve and the profile of the generating tool.

Keywords: *virtual pole method, gear shaped tool, tool profiling, K-profile*

Paper ID: SESSION 3- 26

Impact of process parameters on dimensional accuracy of PolyJet 3D printed parts using grey Taguchi method

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Abstract: In this study, the dimensional accuracy of parts fabricated with PolyJet 3D Printing Direct process is investigated. An L4 orthogonal array was utilized as the design of experiments, while the process parameters examined are layer thickness, build style and scale. A simple prototype was proposed and specified external and internal dimensions were measured using a digital vernier calliper. Grey-Taguchi method was applied for optimizing all dimensional measurements. The effect of each parameter on dimensional accuracy has been identified using ANOM (Analysis of Means), while ANOVA (Analysis of Variances) has been performed to determine each parameter's dominance. Additionally, the results of this study were compared with the findings of a previous optimization study in which the usual Taguchi method was used. It was concluded that 16 μm of layer thickness, glossy style and 50% scale provide the optimum dimensional results, while scale is the most important factor.

Keywords: *Additive manufacturing, PolyJet 3d printing, Optimization, Dimensional Accuracy, Grey taguchi method*

Paper ID: SESSION 3- 34

Research, study, design and development of an artificial ear splint model by using a 3D printer

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Abstract: The aim of this research study centers around the design and development, using a three-dimensional model of an ear-splint. This study results from the need of a non-invasive method, as the current techniques used in otoplasty have succeeded in reducing the risk of complications, but without drastically reducing the rate of postoperative deformity. Indeed, stick out ears present a deformity that occurs in 5% of the population. Factors such as psychosocial impact and intimidation lay the foundations for the need for such a method. This paper essays to create, through 3D printing, a case customized into the ear of any person of all ages. The splint was made on Zortrax M200 3D printer model, equipped with the V3 Hotend head, and the material used for printing was 16 grams of Z-FLEX. It is noted that the creation of the case is innovative and original. After putting the ear-splint into test, by applying it on a human ear, two conclusions emerge. First, it is very light, weight, just 16 grams, and second, it offers comfort and convenience to the user. In order to get results for its practicality, a clinical rehabilitation study is recommended.

Keywords: *Non-invasive, Stick-out ears, 3D printing, Z-Flex*

Paper ID: SESSION 3- 39

Skills Requirements for the 4th Industrial Revolution: The Additive Manufacturing case

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Abstract: This work analyses the required expertise knowledge for the European workforce under the implementation spectrum of the technologies from Industry4.0. The advancement of the conventional manufacturing technologies with complementary monitoring and control systems combined with the rapid growth of unconventional manufacturing technologies, calls for the equivalent advancement in the workforce's expertise. The Industry's 4.0 skills are mapped and categorized based on the knowledge requirements derived from the major technologies involved. The competences' categorization is what further determines the Professional Profiles and skills requirements for the Industry4.0. As Additive Manufacturing is one of the most significant manufacturing technologies implemented from Industry4.0 a case study for the required AM skills is performed. The outcome of this work indicates that the AM Professional Profile is a multi-dimensional quantity with multiple competence units that require validation and further evaluation in order to meet the skills requirements imposed by the industry.

Keywords: *Industry4.0, Skills, Competence, Additive Manufacturing*

Paper ID: SESSION 3- 50

Usability evaluation of mechatronic system by primary school children

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Abstract: The paper examines the ease of use of a mechatronic system by children aged 7-12+ years living in the area of Thessaloniki. The research was conducted on students who participated in educational robotics seminars and as the results show, the trainees consider a mechatronic system very easy to use. The study concluded that older boys in particular were more familiar, than girls, in the construction and the programming of mechatronic systems. Children seem to be excited and this is evidenced by their strong desire to use it often. The area criterion does not make difference to the results. It seems clear that a mechatronic system is easy to use by primary school children. Through educational robotics, children can be taught in the different objects that combine this special tool. Learning takes the form of a game and escape from the narrow boundaries of conventional teaching that is now outdated and without interest.

Keywords: *Education robotics, mechatronic systems, usability*

Paper ID: SESSION 3- 53

Electrospun PCL-Surgihoney meshes for skin wound healing applications

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Abstract: Skin is a complex and very important tissue, playing a significant protective and regulatory function. It is also prone to a large number of wounds and defects due to external factors such as temperature, chemical agents, and radiation. Accelerating the skin healing process and minimizing the risk of infection is a relevant research challenge. This paper investigates a novel wound dressing based on polycaprolactone (PCL), a synthetic biocompatible and biodegradable polymer, and honey- Surgihoney® (SH). Solution electrospinning was used to produce the wound dressing meshes. Different polymer solutions were prepared by mixing PCL and SH with acetic acid. Human dermal fibroblast were used to assess the biological characteristics of the electrospun meshes. Results show that the presence of SH1 has a positive impact on cell attachment and proliferation.

Keywords: *Electrospinning, honey, polycaprolactone, wound healing*

Paper ID: SESSION 3- 62

A Pedagogical Methodology for Introducing CAD Modeling Tools and 3D Printing Technologies to Adult Trainees

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Abstract: This paper presents a four-step training model based on pedagogical methodologies for introducing CAD (Computer-Aided Design) modelling tools and 3D printing technologies to adult trainees. Nowadays, 3D modeling techniques and 3D printing technologies are emerging core competencies due to the increasing popularity of STEAM education frameworks. The proposed training model has these four stages for trainees' team: a) theoretical background of program based on traditional educational techniques, b) e-learning tools and parallel interaction with the trainer, c) micro-teaching frameworks and case studies and d) brief questionnaires with motivation and satisfaction criteria completed by the trainees. The present paper attempts to identify the pleasure and satisfaction of participating in New Technologies Education through CAD (Computer-Aided Design) modelling tools and 3D printing technologies program.

Keywords: *Pedagogical Methodology, Modern Training Techniques, CAD Modeling, 3D Printing, STEAM, Adult Education, E-learning Tools*

Paper ID: SESSION 3- 79

Starch Sandstones in Building Bio-materials

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Abstract: A review of the recent literature shows that the use of more sustainable, eco-friendly recycled waste materials made from natural biopolymers is an important step of the planning process to reduce the environmental impacts of traditional building materials such as cement and concrete products. This study introduces the application of maize starch in the production of a novel biodegradable construction material. The samples prepared in this investigation were formed by heating a mixture of different proportions of starch, water and sand. The structural properties, morphology and chemical composition of materials were investigated by scanning electron microscopy (SEM) coupled with thermal gravimetric analysis (TGA). The structural characteristics and morphology of the study material to a certain extent resemble natural sandstones, the most common type of sedimentary rocks. Based on the uniaxial compressive strength classification schemes, comparing with the brittle deformation behavior of natural rocks, it can be considered that this material behaves as a polymer - matrix composite with a ductile - thermoplastic mechanical behavior.

Keywords: *corn starch, sandstone, biopolymers, construction materials*

Paper ID: SESSION 3- 82

The mechanical performance of 3D printed hierarchical honeycombs using carbon fiber and carbon nanotube reinforced acrylonitrile butadiene styrene filaments

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Abstract: The aim of this paper is to design hierarchical honeycombs as well as manufacturing such structures with a commercial 3D Printer using Fused Filament Fabrication (FFF) technique. The materials under study are commercial filaments such as acrylonitrile butadiene styrene (ABS), acrylonitrile butadiene styrene/carbon fibers (ABS/CF) and acrylonitrile butadiene styrene/carbon nanotubes (ABS/CNTs). The fabricated hierarchical honeycombs were examined by compression tests in order to evaluate the mechanical behaviour of such honeycomb 3D printed structures. The compression behaviour of the hierarchical honeycombs was assessed also with finite element analysis (FEA) and at the end there was a comparison with the experimental findings. The results reveal that the 2nd order hierarchy presented an increase both in stiffness and strength in comparison with the 0th and the 1st hierarchies which make such designs a suitable for structures require such properties. Also, the results reveal that ABS/carbon fiber constructs outperform the other materials under study.

Keywords: *Mechanical Performance, 3D Printed Hierarchical Honeycomb Structures, Composite Materials, ABS, ABS/CNTs, ABS/CF*

Paper ID: SESSION 3- 83

Vibration isolation performance of an elevator motor using Nitrile-Butadiene Rubber /Multi-Walled Carbon Nanotube composite machine mounts

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Abstract: The objective of this paper is to evaluate the vibration isolation performance of an elevator motor mounted on elastomeric nanocomposite mounts. A series of conventional acrylonitrile-butadiene rubber (NBR) mounts have been reinforced with 20wt% concentration of multi-walled carbon nanotubes (MWCNTs). The vibration isolation capacity of the machine mounts was calculated through the transmissibility of an elevator motor test system. A Finite Element Model (FEM) was introduced and a harmonic analysis based on the ANSYS code has been utilized to investigate the modal behavior of the nanocomposite machine mount/elevator motor system and extract a representative model of the vibrational behavior. The cyclic compression results have revealed that the stiffness and damping capacity of the conventional elastomers can be modified by adjusting the proportion of MWCNTs. Elastomers' vibration isolation performance of the motor was ameliorated with the inclusion of MWCNTs, signifying that the enhancement of the elastomers with MWCNTs was rather effective. The vibration level of the elevator motor was decreased to 90% by incorporating the optimal concentration of MWCNTs in NBR mounts.

Keywords: *Nano composites, Vibration isolation, Elevator motor machine, NBR, Carbon nanotubes*

Abstracts- Session 4

Paper ID: SESSION 4- 8

Progress and recent trends in generative design

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Abstract: Due to recent developments in the field of additive manufacturing enormous advantages have become in product design and manufacturing process. Before the appearance of additive manufacturing, developing very complex or light weight structures was difficult to manufacture. The development of artificial intelligent technology helps to develop new collaborative tools and algorithms. Generative design approach is one of them. The outcome model from a generative design study is not depending only from designer/engineer experience or his knowledge. Designers can react with sophisticated algorithms through CAD programs to specify the shape and the topology of the model. A significant tool on a generative design system is topology optimization which is able to generate different solutions. The changes in design process are significant. A rough conceptual design (sketch) or a 3d model is first prepared. Then, boundary conditions, safety factor, manufacturing limitations and materials properties are defined. The generative design system generates potential solutions. It's up to the designer to find the design that best fits to his need. In this paper the review covers the limitations of current systems through the study of specific design cases using commercial generative design systems.

Keywords: *Generative Design, Topology Optimization, Additive Manufacturing, CAD, Artificial Intelligent*

Paper ID: SESSION 4- 17

3D-Printed Composite Bone Bricks For Large Bone Tissue Applications

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Abstract: This study investigates the use of low cost, customizable, biodegradable, polymer-ceramic composite porous structures (bone bricks) for large bone tissue regeneration. Different ceramic materials (hydroxyapatite (HA), β-tri-calcium phosphate (TCP) and Bioglass (45S5) were mixed with poly-ε-caprolactone (PCL). Bone bricks with different material compositions were produced using an extrusion-based additive manufacturing system. Produced bone bricks were morphologically and mechanically assessed. Results allowed to establish a correlation between scaffolds architecture and material composition and scaffolds performance. Reinforced scaffolds showed improved mechanical properties. Best mechanical properties were obtained with PCL/TCP bone bricks and topologies based on 38 double zig zag filaments and 14 spirals.

Keywords: *Hydroxyapatite, β-tri-calcium Phosphate, Bioglass 45S5, Additive Manufacturing, Tissue Engineering, Bioengineering, Bioprinting*

Paper ID: SESSION 4- 24

Experimental study on noise reduction and performance enhancement for internal combustion engines

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Abstract: As the number of cars increases and large cities become more and more crowded, noise reduction becomes more and more important. The decrease of the fuel consumption and the increase of power to the same cylindrical capacity are always current topics. This paper's aim is to bring a contribution to solving these problems. The proposed solution consists in the use of ceramic materials in the design of the combustion chamber.

Keywords: *internal combustion engine, fuel consumption, materials*

Paper ID: SESSION 4- 30

Experimental Researches to Establish the Optimum Hardbanding Technology and Materials of the Heavy Weight Drill Pipe

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Abstract: The heavy weight drill pipe, one of the most expensive components of the drill string, is exposed, beside fatigue and corrosion, to an intensive wear process as a result of the friction with the inner wall of the casing or the borehole wall, that lead to a drastically decrease of it durability. In order to improve the durability, the worldwide specialists apply the hardbanding technology to increase the heavy weight drill pipe wear resistance. The major problem raised by the hardbanding process is the selection of the most suitable wear resistant alloy and the optimum hardbanding technology. The present research work investigate the possibility of hardbanding the heavy weight drill pipes by using the gas metal arc welding process, taking into considerations three different wear resistant materials with the trade name ARNCO 100XT, ARNCO 300XT and FLUXOFIL M58.

Keywords: *heavy weight drill pipe, hardbanding, welding, wear resistant*

Paper ID: SESSION 4- 47

A novel printing channel design for multi-material extrusion additive manufacturing

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Abstract: Additive manufacturing has a great potential in terms of its capability to produce components with complex geometries and to make multi-material and composite products by combining different materials in a single manufacturing platform. Current trends for the multi-material extrusion additive manufacturing process are categorized by multi-nozzle systems and multi-material inlet systems. In the case of multiple nozzle system, materials are deposited from different nozzles in sequence. On the other hand, in the case of multi-material inlet system, different materials are sent into a mixing tube and deposited as a mixture of materials. In this case, functionally graded parts can be fabricated by changing the volume fraction of two or more materials. Hence, the fabrication of parts with a continuous material supply by varying ratios for the extrusion technologies requires the development of printing heads with suitable printing channels, capable of varying the mixing ratio of different materials. To evaluate the effect of different printing channel designs on the material's flow pattern and the functionally graded material printability, this paper presents a three-dimensional transient computational fluid dynamics (CFD) simulation of the two miscible liquid-liquid system in a printing channel. Different geometries and materials are considered.

Keywords: *Additive manufacturing, CFD, material mixing, printing channel design*

Paper ID: SESSION 4- 51

An AM-oriented vehicle chassis' A-Pillar Design Approach

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Abstract: Design and production of highly demanding structural systems, such as the chassis, still rely on conventional forming and welding approaches, both because of their proven performance and the economies of scale achieved. Nevertheless, manufacturing of several chassis' segments is also expected to soon gradually switch towards AM, for increased design freedom and optimized performance. This paper proposes an alternative design approach for the A-pillar, a typical passenger car chassis segment; a design suitable in form for AM and equally capable in terms of its dynamic behavior, without undermining the chassis' safety. Prior A-pillar designs along with already published innovative AM-suited design approaches are reviewed. Moreover, these serve as a starting point for an inverse design towards the intended new AM-suited A-pillar alternative. Emphasis is given in the dynamic characteristics of the new structure, through proper modal analysis performed. Finally, the presented research concludes with a scaled-down assessment and verification prototype of the new design, planned to be built via FDM 3D Printing. The prototype is expected to demonstrate primary, as well as secondary/latent benefits from the use of AM in A-pillars, such as the increased diagonal visibility for drivers and passengers, arising from the redesigned, mesh-like form of the segment.

Keywords: *A-Pillar, Design, Additive Manufacturing, Structural Integrity, Modal Analysis, 3D Printing*

Paper ID: SESSION 4- 67

3D Printing Assisted Product Design Addressing Refugees Needs

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Abstract: With one of the largest refugee crises of modern times currently occurring, the need for technology-based solutions to address related pressing issues is eminent. In the past few years, 3D printing has attracted considerable attention as a technology that could help to address specific refugees needs in a customized way. The aim of the presented work was to investigate and demonstrate the contribution of 3D printing to the design of specific products that could easily and rapidly manufactured to assist the refugees integration into the host country. Specifically, the undertaken study focused on facilitating the integration of refugees' children into the Greek society through the design and 3D printed toys for educational purposes. It is demonstrated in this preliminary study that such 3D printed toys can be proven a powerful tool for improving the integration process of displaced people by making the learning of a new language a pleasurable experience.

Keywords: *3D Printing, Product Design, Educational Toys, Refugees*

Paper ID: SESSION 4- 71

Design of 3D printed smart material compatible hand prosthesis

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Abstract: Every year there are about 3500-5200 people suffering from upper limb amputations, most of which are wrist disarticulation and transcarpal. This paper investigates current upper limb prostheses and presents the disadvantages of current prostheses, including limited degrees of freedom (DOF), limited range of motion, weight, customizability, and appearance. The proposed design is the first stage of a series of papers that proposes designs that are compatible with shape morphing materials. The use of these materials as actuators allows the development and design of more advanced upper limb prostheses. Therefore, the prosthesis is modelled as needed for patients with transcarpal/wrist disarticulation amputations. The proposed model has 27 degrees of freedom (DOF), reduced weight, low cost, improved appearance, and is printable to fit.

Keywords: *3D printing, prosthesis, upper limb, design, degrees of freedom, amputation, morphing materials, Prosthesis*

Paper ID: SESSION 4- 78

Computer modelling and simulation of a novel printing head for complex tissue engineering constructs

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Abstract: In tissue engineering, three-dimensional functional scaffolds with tailored biological properties are needed to be able to mimic the hierarchical structure of biological tissues. Recent developments in additive biomanufacturing allow to extrude multiple materials enabling the fabrication of more sophisticated tissue constructs. These multi-material biomanufacturing systems comprise multiple printing heads through which individual materials are sequentially printed. Nevertheless, as more printing heads are added the fabrication process significantly decreases, since it requires mechanical switching among the physically separated printheads to enable printing multiple materials. In addition, this approach is not able to create biomimetic tissue constructs with property gradients. To address these limitations, this paper presents a novel static mixing extrusion printing head to enable the fabrication of multi-material, functionally graded structures using a single nozzle. Computational fluid dynamics (CFD) was used to numerically analyze the influence of Reynolds number on the flow pattern of biomaterials and mixing efficiency considering different miscible materials.

Keywords: *Additive manufacturing, multimaterial bioprinting, CFD, material mixing*

Paper ID: SESSION 4- 84

Prediction of the main cutting force in longitudinal turning of AISI D6 tool steel bars by applying full and fractional experimental design

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Abstract: This investigation concerns the cutting force magnitude during turning of AISI D6 tool steel using both Taguchi Experimental Design (TED) and full factorial design (FFD). Three main cutting parameters namely spindle speed, feed rate and depth of cut were considered as the cutting parameters, each one having three levels, while the cutting force (Fc) was selected as the machinability process output. The full factorial design of the 27 (33) experiments was splitted in three sub-arrays, each one having 9 experiments. These three sub-arrays were orthogonal and were treated as Taguchi L9 orthogonal arrays. The performance of the FFD and each TED was analysed using stem-and-leaf plots, box plots, as well as analysis of means (ANOM) and analysis of variance (ANOVA). The results obtained indicate the suitability of all proposed experimental designs for machinability studies.

Keywords: *DOE, Tool steels, Longitudinal turning, Cutting forces, Analysis of variance*

Abstracts- Session 5

Paper ID: SESSION 5- 21

Advanced technologies for shoe sole production

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Abstract: Advanced technologies for modelling and production are an important part in the whole process of product manufacturing. These advancements have changed the way of product development and play an important role in customization. In the footwear industry, as in any other industry, the use of these technologies is widely spread. Footwear comfort is one of the main selection criteria for purchase. Considering this fact, a case study of different steps for shoe designing according to individual foot shape will be presented. Taking into consideration the aesthetics of the sole and in a more sustainable view, through topological optimization reducing of material wastage for sole production will be presented. By means of the topological optimization in the shoe design process, sole optimization is realized. As a part of personalization, feet's plantar pressure maps taken from 1 participant gave a better explanation of weight distribution of each foot. Following, sole personalization according the plantar pressure maps for each foot gives the possibility to obtain the best least material design according to the feet's pressure while maintaining biomechanical performance.

Keywords: *3D sole design, topological optimization, lattice design*

Paper ID: SESSION 5- 36

Design and Analysis of a 5-Axis Gantry CNC Machine Tool

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Abstract: In this study, design and analysis of a gantry-type 5-axis CNC machine tool is presented with experimental results on a manufactured prototype. Critical points in the design of a large-scaled and heavy-duty machine tool is discussed. Moreover, FE analysis results is also presented with detailed discussion. The measurement results on structural dynamics is shown together with the FE results. Furthermore, the final performance of the machine tool is demonstrated thorough position and velocity measurements of the axes.

Keywords: *CNC Machine Tool, Design, Analysis*

Paper ID: SESSION 5- 37

Design of a spiral bevel gear acc. to ISO 23509:2006 standards

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Abstract: When the transmitting of power and torque between parts of a machine requires high efficiency, the most appropriate type of gears are the bevel gears. The two main forms of bevel gears are straight and spiral bevel gears. Manufacturing of bevel gears has been implemented using dedicated bevel gear cutting machines. These machines make the production of this type of gears quite costly. This is the main reason that forced many manufacturers start using CNC milling machines for cutting bevel gears. A combination of a 5-axis milling center machine and a modern computer aided manufacturing (CAM) system that supports a vast number of complicated machining procedures, offers the opportunity of machining high quality bevel gears. This paper concerns the presentation of a program written in MATLAB that calculates the basic designing features of a bevel gear pair, as they described by ISO standard. It is also presented the calculated tooth profiling that is used in order to be designed a 3-D model of the gears in a CAD software.

Keywords: *bevel gears, designing features, tooth profile, manufacturing*

Paper ID: SESSION 5- 63

Non-destructive testing of welded fatigue specimens

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Abstract: Non-destructive tests were conducted on welded fatigue specimens prepared using the same steel material and welding method as the one used in the manufacture and repair procedures of a KRUPP SchRs 600 bucket wheel excavator to reveal any defects present. The chemical composition, the mechanical properties, tendency to cracks and the microstructure of the bucket wheel material were determined using appropriate tests. The initiation of cracks and their subsequent growth during fatigue testing of the welded specimens was studied using ultrasound testing (UT) and a metallographic examination in order to investigate the causes of failure during service and predict fatigue life of the bucket wheel welded parts. It was found that the welding method used produces welds with numerous discontinuities that can only be detected using ultrasound techniques.

Keywords: *bucket wheel, welding, fatigue, non-destructive testing*

Paper ID: SESSION 5- 68

Prospective analysis of the impact of a pandemic in Industry 4.0

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Abstract: The world population in 2020 was estimated at 6.070 million and is projected to grow to around 9 billion by 2050. The evolution and transformation of society in the technological field is a challenge due to its rapid evolution and the social consequences it triggers. The pursued aim is the prospective analysis of diverse scenarios directed by Industry 4.0 macro-drivers, breeding cornerstones for the purpose to presage future pandemic backdrop. In accordance with the evolution of the force for change due to the analyzed factors, a series of recommendations and future work is elaborated to create a weapon to confront this possible context.

Keywords: *Smart Manufacturing, Industry 4.0, Pandemic*

Paper ID: SESSION 5- 69

3D finite element analysis of Al7075-T6 drilling with coated solid tooling

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Abstract: Due to the fact that simulation of drilling was added in commercial finite element analysis (FEA) software only recently, 3D finite element modelling is an invaluable asset during related researches. The present study employs 3D FEA to model the drilling process of Al7075-T6 alloy with solid carbide tooling, investigates important phenomena that occur during drilling and finally compares the simulated results with experimental data. A number of simulations were performed with DEFORM3D™ software at different cutting conditions; cutting speed of 50m/min, 100m/min, 150m/min and feed of 0.15mm/rev, 0.20mm/rev, 0.25mm/rev. The proposed model takes into consideration certain aspects like damage initiation and evolution of the material, contact interface between the drill bit and the workpiece and standard boundary conditions. Eventually, the acquired numerical data for thrust force were compared to the experimental results for the same cutting conditions and parameters. To obtain the experimental data, a series of nine drilling tests were performed. Upon validation of the numerical data, the temperature distribution on the tool tip – workpiece interface, as well as the chip morphology (shape and curling radius) were determined. Results showed a good agreement between the numerical and the experimental data. Specifically, thrust force and chip morphology exhibited an agreement of about 95% and 90% respectively, which confirms the potential of 3D FEA implementation on machining investigations.

Keywords: *FEA, drilling, manufacturing simulation*

Paper ID: SESSION 5- 75

A Space-Time POD Basis Interpolation on Grassmann Manifolds for Parametric Simulations of Rigid-Viscoplastic FEM

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Abstract: Parametric simulations of thermo-mechanical metal forming processes still remain computational costly and dicult due to inherent strong non-linearities. To this end, Reduced Order Models (ROMs) are introduced to decrease the computational time in large scale models and provide near-optimal solutions in acceptable times. ROMs based on the Proper Orthogonal Decomposition (POD) are usually capable of accurately reproducing the dynamics of high-fidelity FEM simulations and oer the potential for near real-time analysis. Unfortunately, ROMs are not robust with respect to parameter changes and therefore must often be rebuilt for each parameter variation. This work aims to interpolate ROM POD basis associated with a limited number of training points on Grassmann manifolds, so as to obtain a robust ROM corresponding to a target parameter. A Space-Time (ST) POD basis interpolation, where the reduced spatial and time basis are separately interpolated on Grassmann manifolds is investigated. Good correlations of the ROM ST models with respect to their associated high-fidelity FEM counterpart simulations are reported, thereby highlighting the potential of the ROM adaptation method for near real-time metal forming simulations using o-line computed ROM POD databases.

Keywords: *Rigid-Viscoplastic FEM, Metal Forming, Proper Orthogonal Decomposition (POD), Reduced Order Models (ROMs), Grassmann manifolds*

Paper ID: SESSION 5- 76

Modeling and simulation of the nanosecond pulsed laser engraving process

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Abstract: In this paper a 3D finite element simulation model of the nanosecond pulsed laser engraving process will be presented. With this model simulations of laser engraving process will be performed for some widely used materials using a wide range of process parameters in order to estimate the removed material layer thickness at each laser scan over the surface of the workpiece. Determining the removed material layer thickness is an important task because the machine must receive this value as input from the operator to calculate how many passes-layers need to be made in order to achieve the desired final depth of engraving. Since there is no simulation tool for this purpose at this time, the removed material layer thickness is determined through an experimental procedure. However, this procedure is time consuming as it has to be carried out each time separately depending on the process parameters, the material used, etc.

Keywords: *Laser machining, Simulation, Finite elements method*

Abstracts- Session 6

Paper ID: SESSION 6- 12

Stop wasting! A plea for maintenance

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Abstract: It is produced, it is worn out, it is thrown away, it is becoming more and more polluted, it is recovering, but it is not completely away, and therefore the material reserves are diminished and some have become even deficient. The handiest solution, at least to slow down the dynamics of pollution and draining of supplies of materials and materials is maintenance. In the following we will explore this solution to make it as efficient and available as possible in industrial application.

Keywords: *waste, maintenance, reparation, recovery, design for maintenance*

Paper ID: SESSION 6- 16

Effect of machine hammer peening on the surface integrity of a ZnAl-based corrosion protective coating

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Abstract: Thermally sprayed protective coatings are applied onto many mechanically stressed components such as support structures, shafts, turbine blades or heat exchangers. In addition to the static or cyclic load, a superimposition with corrosion processes occurs in many cases. Thermal sprayed ZnAl coatings are known for their performant corrosion protection properties. Within this context, the potential of ZnAl-based layer systems was analyzed regarding corrosion fatigue behavior. Therefore, a time- and cost-efficient testing strategy based on a corrosion-superimposed load increase procedure was used to estimate the effects of a corrosive attack during cyclic loading. The investigated coating systems were thermally sprayed and partially post-processed with a Machine Hammer Peening (MHP) operation. This treatment was identified as an appropriate technique for compressing and smoothing coated surfaces. The inter-relationships between the parametrization of the MHP process, the resulting surface integrity, and the estimated corrosion fatigue properties were analyzed. The investigations indicate a positive effect of MHP post-processing operations on the surface properties of the ZnAl-based coating system.

Keywords: *Machine Hammer Peening, Arc sprayed ZnAl coatings, Corrosion fatigue*

Paper ID: SESSION 6- 18

Preliminary studies on the suitability of PETG for 4D printing applications

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Abstract: Shape memory polymers represent a class of polymers that can recover its original shape under stimulus. This paper presents the preliminary results of a broader research programme that investigates the potential use of polyethylene terephthalate glycol (PETG), a glycol modified version of polyethylene terephthalate (PET), for the fabrication of smart bone tissue engineering scaffolds. PETG. A full characterization analysis is carried out, including chemical analysis, mechanical analysis and shape recovery characteristics. Chemical analysis show the presence of terephthalic acid (TPA), ethylene glycol (EG) and cyclohexanedimethanol (CHDM) in the polymer structure. Mechanical analysis, considering a quasi-static tensile test, shows that PETG presents better than PET. Shape recovery is assessed using a cyclic thermomechanical experiment where stress and temperature are controlled during the programming and recovery phases and demonstrates that PETG is able to change and recover its initial shape.

Keywords: *Additive Manufacturing, Advanced Material, Smart Material, Shape Memory, Polymer, 4D printing, Chemical analysis, Compositional analysis*

Paper ID: SESSION 6- 29

Tribological Characterization of Some Elastomers Used at Progressive Cavity and Piston Pumps

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Abstract: The progressive cavity pump (PCP) is a positive displacement pump, consisting of a polished helical-shaped rod (rotor) turning inside a helical elastomer (stator). PCP has many advantages, but the pump durability is manly limited by elastomer behavior. At piston pumps (PP) used for drilling mud piston has an elastomer sleeve that also limit the durability. Standards like ISO 15136.1 & 2 for pumps developed by manufactures and users' committees provides requirements for design, quality design verification etc., but do not define specifically the elastomer for the stator or the metal used for the rotor. Each PCP and PP manufacturer used specific materials at pump construction. The aim of this study was to evaluate the tribological behavior of some elastomers such polybutadiene rubber (BR), polybutadiene acrylonitrile rubber (NBR), polybutadiene acrylonitrile carboxylate (XNBR) and polyamide (PA 6) in couples with hard chromium coated steel, nitride steel and cast iron. Were determined friction coefficients and wear on 2 types of friction couples (plane to plane and shoe to plane) on two tribometers and some mechanical proprieties (Young's modulus, ultimate tensile strength, elongation, hardness).

Keywords: *progressive cavity pump, elastomers, friction coefficients, wear*

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Green Face of Packaging – Sustainability Issues of the Cosmetic Industry Packaging

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Abstract: Packaging is a steadily growing industry that faces many challenges as well. Ever growing consumer expectations, though competition, technological advances don't come even close to the huge issue of sustainability within the industry. Packaging for the beauty industry is dependable on the looks more than any other with massive changes in the recent years since extensive grooming became a part both genders lifestyle today and spreading those standards across the globe. The global cosmetic packaging market was valued at USD 25.9 billion in 2018 and is expected grow 4.8% in the next 5 years flying high on the innovative package designs, increasing demand for cosmetics focused on the middle class and youth as well as e-commerce. The first stepping stone is that more than half of the materials used for the massive cosmetic industry packaging are plastics. Finding alternatives and making a shift to a greener and circular way will be a challenge in the years to come.

Keywords: *Design, packaging design, sustainable design, new materials, plastic alternatives*

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Circular economy framework for sustainable product design strategies

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Abstract: Limited global resources, climate changes, growing population, combined with demand for sustainable products, indicate the need for change of existing production and consumption practices. In order of achieving more regenerative, restorative, and circular economy, design has been recognized as a catalyst for moving away from the traditional linear economy model (take-make-dispose). As shifting focus from quantity to quality, and finding new ways of working in cooperation with the nature, slowly becoming paradigm, it is important for designers committed to sustainability to have in mind environmental, social and economic performance of product design. This paper aims to address position of different product design strategies correlated with circular economy concept, as well as the opportunities for designers' to shift their mindset from the position of creators to solution providers.

Keywords: *Design, design strategies, sustainability, circular economy*

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Research Methods And Experiments of Piezoelectric Plates

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Abstract: The correct design of technical systems requires consideration of both geometrical and material parameters not only of the mechanical part, but also of the electrical part of the system. The correct assessment of characteristics and testing of intelligent systems should be carried out by both theoretical analyzes and laboratory tests. Usually this description is by means of mathematical equations. The ideal solution is in which it is possible to refine the object in such a way that the obtained model is the most accurate, and even the same as the physical model. Considering the complexity of the model, computational cost, computational possibilities and time-consuming calculations would practically prevent the use of this model. Intelligent materials are more often used for active vibration damping. They can be defined as a group of materials that have the ability to change their physical properties in an appropriate way as a result of external influences. One of the most popular materials in this group are piezoelectric materials. They are used where it is necessary to reduce vibrations with small amplitudes of μm and work in high frequency ranges. In the presented article, the author will attempt to refine the model of intelligent materials with particular emphasis on piezoelectric plates.

Keywords: *modelling, analyses, PZT, experiment, piezoelectric plates*

Paper ID: SESSION 6- 86

Aluminum gas atomization through a Venturi Nozzle

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Abstract: A new concept of powder atomization based on the venturi phenomenon is presented in the current work. In the proposed method, the working gas speeds-up while flowing into the venturi nozzle. Under the low static pressure developing at the narrow part of the venturi, liquid metal is sucked and mixed perfectly with the gas. By controlling the operating parameters, metal powder of different sizes and shapes can be produced. Carbon dioxide and pure aluminum were mixed in the nozzle and the effect of different operating gas pressures on the produced particle size and shape were thoroughly investigated. Most of the particles were found to average to almost 150 μm, however, even sub-micron aluminum particles were produced at low mass fractions. With the increase of the gas pressure from 0.5 bar to 4 bar, finer aluminum particles are produced. One of the most attractive features of the proposed method is the low gas pressure required to cause melt atomization, which in certain cases may be up to 30 times lower compared to current industrial atomization methods.

Keywords: *gas atomization, low pressure, aluminum powder*

Paper ID: SESSION 6- 86

Growth of hydrophobic membrane on copper surface and study of its corrosive behaviour

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Abstract: Hydrophobic films were produced on a copper surface by chemical methods. The whole process consisted of three stages. Initially the hierarchical structure of the surface was achieved by in situ reduction of Ag+ ions to Ag using silver nitrate solution, thereby creating a nanostructured surface. The copper surface was then coated with polydopamine by a simple immersion procedure. Finally, it was decorated with thiols, to achieve a hydrophobic surface. The wetting angle was used to evaluate the hydrophobicity of the produced surfaces. The anti-corrosion behavior of the produced hydrophobic films, were evaluated on the specimens that showed higher hydrophobicity by electrochemical methods. Electrochemical techniques (potentiodynamic polarization and resistance spectroscopy tests) were performed in 3.5% NaCl solution. Morphology was investigated by scanning electron microscopy (SEM). All experimental results showed a clear improvement in the corrosion behavior of the hydrophobic copper surfaces while the hydrophobicity was maintained after the corrosion tests.

Keywords: *hydrophobic film, corrosion behaviour, microstructure, copper*

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