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# yCAM 2020

Conference Abstracts

**young Ceramists Additive Manufacturing Forum 2020**

**October 28-30 2020**
**Online conference in gather.town**

Editors

**David Karl, Giorgia Franchin, Andrea Zocca**

https://www.euroceram.org/en/events/ycam-2020-forum

## Conference Committee

**David Karl** received a diploma in fine art from Braunschweig University of Art (2010) studying with Nicola Torke, Jospehine Pryde, Dörte Eißfeldt and Thomas Rentmeister. He earned a Master of Fine Arts at the Slade School of Fine Art of University College London (2012). In 2015 he obtained a bachelor's degree in materials sciences from Technical University of Berlin. At present, he is pursuing a Ph.D. at the chair of Advanced Ceramic Materials headed by Prof. Dr. Aleksander Gurlo. Since 2016 his work has been supported by the Evonik Foundation. His current research focuses on the Additive Manufacturing of composites as well as ceramic materials.

**Andrea Zocca** graduated from the University of Padova (Italy) with a Bachelor's degree (2009) and Master's degree (2011) in Materials Engineering. In 2015 he obtained a PhD in Materials Engineering from Clausthal University of Technology (Germany) and the University of Padova, in the frame of a joint doctorate. During his PhD studies he worked at BAM, Federal Institute for Materials Research and Testing, Berlin (Germany) and at Department of Industrial Engineering, University of Padova (Italy). In 2015 he obtained an Adolf Martens post-doc fellowship at BAM. Currently, he is post-doctoral researcher at BAM in the division of Ceramic Processing and Biomaterials. His main research interests are in the Additive Manufacturing of ceramic materials, with focus on technical ceramics and on the processing of preceramic polymers.

**Giorgia Franchin** graduated from the University of Padova (Italy) with a Bachelor's Degree (2011) in Materials Engineering, where she also obtained a Master's degree (2013) in the same field. She is conducting her PhD studies in the Industrial Engineering Graduate School of the University of Padova, working mainly on direct ink writing of ceramics using preceramic polymers and geopolymers to produce highly porous ceramic lattices and bioceramic scaffolds. During her PhD studies she worked at Massachusetts Institute of Technology Media Lab with the Mediated Matter group on the development of an extrusion based 3D printing process for molten glass. She has been a delegate of the President's Council of Student Advisor of the American Ceramic Society since 2015.

## Responsible for the content:

The respective authors are solely responsible for the content of their abstracts.

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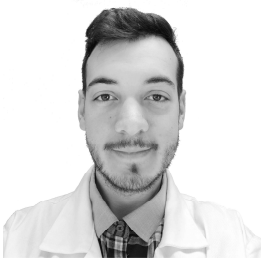
## Local Organizing Committee yCAM 2020

**Pedro Navarrete Segado** graduated from the University of Jaen (Spain) with a Bachelor's degree (2016) in Chemistry and a Master's degree in Nanostructured materials for nanotechnology applications in the University of Zaragoza (Spain). After his Master (2017) he was recipient of an European grant, Vulcanus in Japan (EU-Japan Center), including an industrial placement at Hitachi, Ltd. - Central Research Laboratory, developing, as research assistant, new technologies related to the characterization of materials. Currently he is pursuing a PhD thesis at National School of Engineering in Chemical and Technological Arts at Toulouse INP with the tailoring of calcium phosphate powder properties for SLS/M techniques as thesis topic.

**Alejandro Montón Zarazaga** graduated from the University of Zaragoza (Spain) with a Bachelor's degree (2016) and Master's degree (2018) in Physics and Physical Technologies. Since 2018, he has been pursuing a PhD thesis at the National School of Engineering in Chemical and Technological Arts at Toulouse INP. In parallel to his PhD, he is a Marie Curie Fellow early stage researcher in the Inter-University Center for Materials Research and Engineering (CIRIMAT) and part of the European project DOC-3D-PRINTING. His main research interest is in the silicon carbide based 3D printed materials. He is working on selective laser sintering and its potential to generate full dense additive manufactured silicon carbide parts.

**Eren Özmen** graduated from the Istanbul Yildiz Technical University with a Bachelor's degree (2016) in Metallurgy and Materials Engineering. Shortly after, he joined the research team of Prof. Alicia Duran in the Institute of Glass and Ceramics with an Erasmus+ scholarship. And in parallel, he got his Master's degree in Molecular Nanoscience and Nanotechnology in the Autonomous University of Madrid. Currently, he is doing his PhD on multi-material ceramic-metallic printing at the National School of Engineering in Chemical and Technological Arts at Toulouse INP as a Marie Curie Fellow early stage researcher.



**Giovanni Urruth Bruno** graduated from the Federal University of Rio Grande do Sul (Brazil) with a Bachelor's degree (2015) and Master's degree (2018) in Materials Science and Engineering. In between he was awarded with one year scholarship for the project 'Mynasis - advanced training in micro and nano systems' at École Polytechnique Universitaire de Montpellier (France). In 2017 he obtained a post-graduate certificate in Work Safety Engineering from Pontifícia Universidade Católica do Rio Grande do Sul (Brazil). Currently part of the European project DOC-3D-PRINTING as a Marie Curie Fellow early stage researcher at Marion Technologies (France) to pursuit his PhD, he is working on tailoring and optimizing ceramic powders for additive manufacturing.

The **young Ceramists Additive Manufacturing Forum (yCAM)** is a conference and networking platform organized by **Europe Makes Ceramics (EMC)** and supported by **European Ceramic Society (ECerS)** and **JECS Trust**.

The **yCAM** conference is dedicated to young scientists who are developing a career in the field of additive manufacturing of ceramics or are entering this topic.
**yCAM** covers the main AM technologies applied to ceramics and, in particular, the following topics:

**Technologies:**

- Robocasting / Direct ink writing
- Stereolithography
- Powder-based 3D printing
- Selective laser sintering/melting
- Direct inkjet printing
- Laminated object manufacturing
- Novel Additive Manufacturing technologies

**Additive Manufacturing materials and technologies:**

- Silicate ceramics, pottery, ceramic art and architecture
- Technical ceramics and advanced applications: bioceramics, porous ceramics, piezoelectric ceramics, printed circuits etc.
- Composites and multi-material Additive Manufacturing

**Design and software**

Innovative and process-driven design

Software and data preparation for Additive Manufacturing

**yCAM in the past**

The first **yCAM 2017** conference was held in Berlin at the **Chair of Advanced Ceramic Materials of Technical University Berlin**:

The young Ceramists Additive Manufacturing Forum (yCAM) took place on March 23-24 2017 in Berlin, Germany. The conference has been hosted by the Technical University Berlin, Fachgebiet Keramische Werkstoffe.

yCAM 2017 had a very positive response of international participation, with 63 registered participants coming from institutions situated in 11 different European countries and guests from Iraq and China. Two keynote presentations from senior researchers were delivered by Dr. Martin Schwentenwein (Lithoz company, Austria) and Dr. Fabrice Rossignol (CEC Limoges, France). The major part of the program, split over 4 sessions in two days, included 20 presentations from young scientists. In addition, the participants enjoyed the possibility of taking part in the conference dinner on the evening of March 23rd and in the visit to 3D Lab at the Technical University of Berlin.

The second **yCAM 2018** took place in Padua and was sponsored by the **JECS Trust** and by **La Società Ceramica Italiana (ICerS) yCAM 2018** was patrocinated by the **University of Padova and the Industrial Engineering Department.**

yCAM 2018 had a very positive response of international participation with almost 100 registered participants coming from institutions situated in 19 different countries. Four keynote presentations from senior researchers were delivered by Prof. E. Saiz (Imperial College, UK), Prof. G. Bertrand (CIRIMAT, France), Dr. R. Gaignon (3DCERAM, France) and Dr. E. Mancuso (Ulster University, UK). The major part of the program, split over 8 sessions in two days, included 28 presentations from young scientists. In addition, the participants enjoyed the possibility of taking part in the conference dinner on the evening of May 3rd and a visit to MUSME (Museum of History of Medicine in Padova).

The third **yCAM 2019** took place on April 3-5 2019 in Mons, Belgium. The conference was sponsored by the **JECS Trust** and was patrocinated by the **University of Mons and Belgian Ceramic Research Center**. yCAM 2019 had a very positive response of international participation with 139 registered participants coming from institutions situated in 23 different countries and also attracting participants from the industry. Three keynote presentations from senior researchers were delivered by Dr. Andrea Zocca (BAM, Germany), Dr. Amin M'Barki (Institut Pierre-Gilles de Gennes, France) and Dr. Pablo Gonzales (Admatec, The Netherlands). Two informative presentations introducing the topics of Discrete Element Simulation and the 3D imaging of architected materials were delivered by Dr. Christophe Martin and Dr. Eric Maire in the frame of an exchange with the Rise AMITE European project.

The major part of the program, split over three days, included 31 presentations from young scientists. Also, the participants enjoyed the possibility of taking part in a conference dinner on April 4th and in a visit to the laboratories of BCRC (**Belgian Ceramic Research Center**).

# DLP printing of viscoelastic hydrogel/calcium phosphate composites for bone tissue replacement

Wednesday, 28th October: Poster session I - Poster - Abstract ID: 222

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3D-printing, and more specific, stereolithography, is a promising technique to fabricate materials for the restoration and regeneration of different tissues. Photopolymerization of different materials underlying the technique and combining biodegradable, osteoconductive, osteoinductive and required mechanical properties, allowing easily managing architecture and macroporosity of the material, is very attractive for regenerative medicine purposes. All of the parameters are extremely significant in the case of bone healing implants. This work was aimed at obtaining of viscoelastic hydrogel/calcium phosphate composites with complex architecture («gyroid»-type) through DLP 3D-printing assuming personalized bone tissue regeneration.

Hydrogels based on polyethylene glycol derivatives (PEG-diacrylate or PEGDA (M=575 Da), PEG-methacrylate or PEGMA (M=350 Da)), were chosen as one of the most commonly used and biocompatible synthetic polymers for biomedical applications, with adjustable viscoelastic mechanical and swelling properties, and applicable for DLP printing. Reinforcement and functionalization of hydrogel matrices were carried out by filling with calcium phosphates with various micromorphology and resorbability, *viz*. brushite ($CaHPO_4 \cdot 2H_2O$), octacalcium phosphate ($Ca_8(HPO_4)_2(PO_4)_4 \cdot 5H_2O$, OCP), or ceramic particles of tricalcium phosphate ($Ca_3(PO_4)_2$, TCP). Such biocomposites were obtained through light exposure with UV-lamp or with 3D-printer Ember (Autodesk, USA) of the slurries containing biocompatible photoinitiator Irgacure® 819 (BASF, Germany).

Based on the results of the work, the optimal ratio of the monomers and the filling fraction of calcium phosphates in hydrogels were found. It was shown that the increase of methacrylate content allows obtaining composites with a higher swelling ability (up to *ca.* 4 times in terms of mass gain) and faster biodegradation behavior. Reinforcement of the hydrogels with the calcium phosphate particles led to greater stiffness as well as to the growth of the phase shift between shear loss and storage modules.

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