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SUPSI

DRAFT

Concept of a Collaborative Development of a new Research Instrument for Additive Manufacturing by Stereolithography

With this concept a collaborative development of the universities of applied sciences ZHAW and SUPSI, and potential industry partners or other stakeholders in the field of additive manufacturing (AM) is suggested. The aim of the collaboration is the development of a device serving as a modular research and educational platform for exploration of potentials of stereolithography based additive manufacturing, particular of particle loaded suspensions for the production of composites, ceramics and metals. ZHAW and SUPSI have considerable experience either in the field of stereolithographic processing of suspensions for ceramic printing [1] and in the design and AM of complex ceramic articles [2-5]. The group of Ceramic Materials at IMPE Institute of Materials and Process Engineering of ZHAW, headed by Dirk Penner, employs 3D powder printing of ceramics, micro extrusion based printing of ceramic pastes and composites [6] and stereolithography of either particle loaded suspensions [7] or polymer derived ceramics [8]. The group of Hybrid Materials at SUPSI Institute for Mechanical Engineering and Materials Technology, headed by Alberto Ortona, is active in the complete manufacturing chain of complex ceramic architectures always driven by end-users' requirements. In this sense the group has a large experience in designing and producing ceramic objects which can be realized only by AM the main AM technique employed at the HM labs is stereolithography. Both groups have a university internal network of engineering and robotic groups (ZPP[1], IMS[2] at ZHAW, ISTEP[3] at SUPSI) with extended experience in operation, construction and control of AM devices.

For the assessment of applicability of stereolithography technics so far some commercially available systems were evaluated (Asiga, Robot Factory, Formlabs, Gizmo, Lithoz) or are currently under evaluation. During discussion of experiences and issues of all these devices between both institutions ZHAW and SUPSI it turned out, that all systems have major specific technical drawbacks and results are not satisfying for the applications in mind.

[1] Zentrum für Produkt- und Prozessentwicklung
[2] Institut für Mechatronische Systeme
[3] Institute of Systems and Technologies for Sustainable Production

As a result, the idea of a modular research platform was born, where the two main system components of stereolithoraphic AM printers could be exchanged and tested. This are on one hand light sources (Laser, LED, Beamer DLP) and on the other hand the build platform. Especially the design of new concepts of build platforms could circumvent current drawbacks of standard techniques like sticking, mechanical release stresses, no multi-material capabilities, restricted geometrical precision etc.

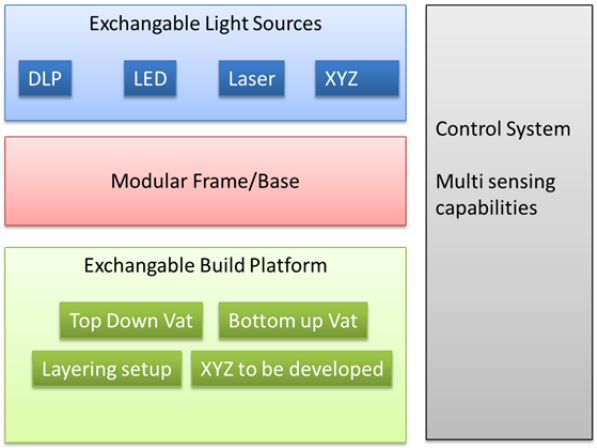

Fig. 1: Modular research platform for additive manufacturing by stereolithography

This innovative approach would give perspectives for swiss machine industries to adapt most successful concepts and for users of high precision shaping techniques like watch industries, mechanical engineering companies, ceramic manufacturers, chemical process engineering developers etc. It would increase the visibility of leadership in the academic community of AM researchers and generally the visibility of innovative swiss AM activities in the mentioned field. Finally, at universities the platform will be developed and run by bachelor and masters students who can contribute to its development while increasing and spreading the know how around the country.

Main focus of ZHAW and SUPSI is applied research and development and transfer of knowledge to swiss industry. **Accordingly partners from swiss industry are sought, who are interested in collaboration and support of the development of such a research platform.** This could be either machine producers or potential users of sophisticated AM technology. Once the basic tool will be developed it could be either licensed, commercialized, used for own production purposes or adapted to other specific needs. Any serious type of collaboration might be possible, although constitution of a consortium of different industry partners and the mentioned academic partners is preferred.

References:

1. Bianchi, G., S. Gianella, and A. Ortona, Design and Additive Manufacturing of Periodic Ceramic Architectures. Journal of Ceramic Science and Technology, 2017. 8(1): p. 59-66.
2. Ortona, A., C. D'Angelo, S. Gianella, and D. Gaia, Cellular ceramics produced by rapid prototyping and replication. Materials Letters, 2012. 80: p. 95-98.
3. Szczurek, A., A. Ortona, L. Ferrari, E. Rezaei, G. Medjahdi, V. Fierro, D. Bychanok, P. Kuzhir, and A. Celzard, Carbon periodic cellular architectures. Carbon, 2015. 88: p. 70-85.
4. Ortona, A., T. Fend, H. Yu, K. Raju, P. Fitriani, and D. Yoon, Tubular Si-infiltrated SiC f/SiC composites for solar receiver application—Part 1: Fabrication by replica and electrophoretic deposition. Solar Energy Materials and Solar Cells, 2015. 132: p. 123-130.
5. Ferrari, L., M. Barbato, A. Ortona, B. Esser, I. Petkov, M. Kuhn, S. Gianella, J. Barcena, C. Jimenez, and D. Francesconi, Actively Cooled Thermal Protections for Future Space Vehicles through Sandwich Structured Ceramic Matrix Composites with Engineered Porous Cores. 2016.
6. D. Penner, A. Fassbind, R. Henke, S. Mauchle, Y. de Hazan, Additive Manufacturing of Ceramics by Composite Microextrusion, cfi 3-4, 2017
7. Y. de Hazan, D. Penner, Low cost ceramic articles produced by stereolithography of preceramic polymers and colloidal ceramic dispersions, ICC6 International Conference on Ceramics, Dresden 2016
8. Y. de Hazan, D. Penner, SiC and SiOC ceramic articles produced by stereolithography of acrylate modified polycarbosilane systems, Journal of the European Ceramic Society, https://doi.org/10.1016/j.jeurceramsoc.2017.03.021

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