Internship /Proposition de stage recherche

Master /PFE Ingénieur et/ou Master M2

Université de Strasbourg - Laboratoire ICube

Mars- août/ March-August 2024

Laser Power Bed Fusion of Lunar Soil Simulants Under Vacuum

Lab: ICube Strasbourg, France
(Laboratoire des Sciences de l'**I**ngénieur, de l'**I**nformatique et de l'**I**magerie)
Engineering science, computer science and imaging research institute

Equipe / Team : IPP (Instrumentation et Procédés Photoniques / Photonics Instrumentation and Processes) en collaboration avec Icam site de Strasbourg-Europe

Context: The IPP team has developed its own 3D printer based on Selected Laser Melting as part of a larger study of lunar soil simulant sintering for lunar base applications. To replicate the lunar conditions such as the lack of atmosphere, a part of the SLS printer is being transferred into a vacuum chamber.

Description: The aim of this internship is to develop an in-situ lunar additive manufacturing process using lunar soil simulants [1, 2], and to find the most adapted light/matter interaction for the most efficient regolith-based manufacturing under certain lunar conditions. More specifically, in the present case, under vacuum.
Recent results are paving the way of solar 3D printing technics to make use of all the in-situ resources [3-5]. Additionally, literature provides information on absorption spectra of the JSC-1A lunar simulant, on the capability of melting [6, 7] or sintering [8] regolith or oxide ceramics and to use of an SLM machine to manufacture parts [9, 10]. Results under vacuum yields porous samples [11]. This can be considered a bonus for insulating applications or a drawback when mechanical strength is required. The latest results report on lunar soil simulants under vacuum and microgravity [12].
The approach our of team and associated partners, the Institut Clement Ader, is more focus on the thermo-optical characterisation of the various simulants to build a robust multi-physics numerical model. The developed numerical model is then used to optimise the light interaction with the matter and sinter samples with the best mechanical properties. These properties will then be characterised by optical microscope, SEM and micro-hardness.
Thanks to the grant FIGOLU obtained from the French space agency, CNES, our team is developing, in partnership with the International Space Agency, an experimental set up inside an existing vacuum chamber.
The conception of the experimental set up inside and around the vacuum chamber has already begun as a student project. The conception of the main frame and powder disctribution system inside the vacuum chamber is done and the parts are currently being manufactured. The Icam students are currently working on final assembly of the system. The trainee will first have to assist the students during the last month of their project to gain knowledge of the system. Afterwards, the trainee will complete the control part of the system (X/Y/Z/rotation stages and laser) and run the first tests to find the most appropriate processing

parameters. To evaluate the quality of the manufactured samples, the trainee will have to perform various physical measures and thermomechanical tests.

Contacts: gregoire.chabrol@icam.fr

Traineeship grant /Gratification de stage :
Gratification de stage conformément aux règles en vigueur (3,90 €/h ~ 600 €/mois).

Poursuite possible en thèse/ Possible PhD position: yes/no Depends on pending and futur funding opportunities

References:

[1] L.A. Taylor et al, Planet. Space Sci., 126, 1–7 (2016)

[2] J.K. Mitchell et al., Geochim. Cosmochim. Ac., Supp. 3, 3235-3253 (1972)

[3] A. Meurisse et al., Acta Astronaut., 152, 800-810 (2018)

[4] A. Ghosh, J.J. Favier, AC-16 Conference, Guadalajara Mex (2016)

[5] D. Mauduit, T. Cutard et al., Materials and Design, Elsevier, 95, 441-421 (2016)

[6] M. Fateri et al., Int. J. Appl. Ceram. Technol., 12, 46-52 (2015)

[7] L. Moniz et al., J. Mater. Process. Tech., 270, 106-117 (2019)

[8] A. Meurisse et al., Journal of Aerospace Engineering, 30, 4 (2017)

[9] A. Goulas et al., Addit. Manuf., 10, 36-42 (2016)

[10] A. Goulas et al., Part L: Journal of Materials Design and Applications, 233, 8, 1629-1644 (2019)

[11] Song Lei, Jiao Xu, Shuqian Fan, Xuan-Ming Duan, Vacuum Sintered Lunar Regolith Simulant: Pore-forming and Thermal Conductivity , Ceramics International 45(3), November 2018, DOI: 10.1016/j.ceramint.2018.11.023

[12] B. Reitz, C. Lotz, N. Gerdes, S. Linke, E. Olsen, K. Pflieger, S. Sohrt, M. Ernst, P. Taschner, J. Neumann, E. Stoll, L. Overmeyer, Microgravity Science and Technology (2021) 33: 25, https://doi.org/10.1007/s12217-021-09878-4