

Czech Technical University in Prague FACULTY OF ELECTRICAL ENGINEERING



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→ Main scientific topics for space activities:

- → Electrochemical power sources, energy storage systems.
- → Photovoltaic, material deposition
- Conductive joining, solder and adhesive joints, material diagnostics, accelerated life testing

Electrochemical power sources



Group leader: Václav Knap

Brief characterization :

04/2022 – til now 02/2019 – 03/2022 02/2012 – 03/2022 Postdoc - CTU Global Postdoc Fellowship Industrial Postdoc in GomSpace (MSc, PhD, RA, PD) na Aalborg University

Space projects:

2019 – 2022 SABER: Nano-satellite battery monitoring – Development of battery lifetime models and battery management systems for nano-satellites. Funded by Innovation Fund Denmark. Main participants: GomSpace A/S (Danish CubeSat development company) and Aalborg University.

WOS H-index: 11

Nowadays team:

- 3 assistant professors
- 1 scientific worker
- 2 PhD students



Electrochemical power sources

Scientific activities

- Investigation of the use of Lithium-ion batteries in CubeSats Prediction and modelling of their performance and life
- Development of a battery management system suitable for CubeSats
- Research and design of energy management system for more efficient use of energy and longer battery life during low-orbit missions
- Selected publication outputs:
 - Knap, V., Beczkowski, S., Vestergaard, L. K., & Stroe, D.-I. (2022). Battery Current and Temperature Mission Profiles for CubeSats at Low Earth Orbit. *IEEE Transactions on Aerospace and Electronic Systems*, 1–1. https://doi.org/10.1109/TAES.2022.3164867
 - Knap, V., & Stroe, D.-I. (2021). Effects of open-circuit voltage tests and models on state-of-charge estimation for batteries in highly variable temperature environments: Study case nano-satellites. *Journal of Power Sources, 498*, 229913. https://doi.org/10.1016/j.jpowsour.2021.229913
 - Bonvang, G. A. P., Fagerlund, F. R., Krøyer, S., Nguyen, K., Thorsager, M., Knap, V., & Tan, Z.-H. (2022). Optimising Battery Charging in CubeSats Using a Long Short-Term Memory Network for Solar Power Predictions. *Submitted*.







Electrochemical power sources



Scientific activities – future plans

- Qualification tests for use of commercial off-the-shelf (COTS) batteries, their selection and optimization
- Research and development of battery management system for CubeSats (with regard to use and restrictions, estimation of charge status, service life, prediction of remaining service life)
- Research and development of energy management system for efficient energy management and long battery life (=> lower solution price, longer missions)
- Thermal battery modelling for optimal system design to increase system reliability and lifetime





Group leader: Jakub Holovský

Nowadays team:

- 1 associate professor
- 2 scientific workers
- 2 PhD students
- 1 technician





OPVVV project, 2017-2022, workpackage: High efficiency crystalline silicon solar cell technology Leader : doc. J. Holovský

The research has one main long-term objective that is 25% efficient solar cell based on silicon passivated contacts technology, optimized for ½ sun irradiance.



Development of new technology for silicon solar cells fabrication

Device fabrication: dopant-free c-Si technology

Automated Wet Bench for Wet Oxidation





Pulsed Laser Deposition of TCO

7









Research of photovoltaic technology of hybrid perovskites









Czech record: achieved efficiency of 21%

Device fabrication: hybrid perovskite solar cells





SPACE activities: radiation resistance of optical materials and devices



activity	potential role	note
radiation resistance of hybrid perovskites	leader, technology and analysis provider	promising fundamental material research
radiation resistance of lamination layers	service analysis	existing small collaboration with UMCh on polymers
diagnostics of solar cells after irradiation	service analysis	
evaluation of optical properties of radiation resistance materials	service analysis	

Conductive joining, material diagnostics, accelerated life testing

Group leader: Karel Dušek

- Nowadays team:
 - 2 associate professors
 - 3 scientific workers
 - 5 PhD students
 - 1 technician
- Basic research
- Applied research
- Industrial corporations







We can offer as protentional leader: reliability of conductive joints and PCBs, development of testing methods

We can support: material analysis, measurement o f material properties, climatic tests

Conductive joining, material diagnostics, accelerated life testing



- → Diagnostic of properties of soldered joints and PCBs
- → Solving of reliability issues in manufacturing process.
- → Solderability and surface tension measurement.
- → Voids formation, tin whisker growth.
- → Electrochemical migration.
- → Ultrasound soldering.



Climatic tests, reliability

➡ Accelerated Life Testing



- Special climatic chamber thermal or UV stress with analysis of outgassing
- → Elevated temperature.
- → High relative humidity.
- → Shock test (thermal shock)
- → Mechanical stress (static/dynamic).
- ➡ Combination.











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