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IAF MATERIALS AND STRUCTURES COMMITTEE

Recent trends and achievements in high-performance, lightweight and innovative materials and structures for space applications.

1. Summary

As the whole space sector, the field of materials and structures is undergoing constant evolution and advancements. In particular over the last 12 months, an increasing trend towards further miniaturization of satellites and launchers has been observed. This is mainly driven by a large number of startups and private entities venturing into the commercial space market, for which SmallSats and MicroLaunchers significantly lower the entry barrier in terms of cost, schedule and risk. Another ongoing trend has been the increased use of lightweight design and optimization via computational approaches. Continuous advancements in the field of computational methods, readily available computational resources and novel manufacturing techniques enable the use of advanced designs even for most challenging, multidisciplinary space applications. The advancement of additive manufacturing techniques furthermore enables the utilization of custom-tailored composites and engineered materials in order to maximize the performance of future materials and structures in an unprecedented manner.

2. Highlights

One of the highlights in the field of materials and structures is the unlimited possibilities enabled by serial additive manufacturing. While additive manufacturing techniques do not only provide almost unlimited geometrical design freedom, they also greatly reduce the complexity, cost and schedule of space systems by minimizing the number of parts and enhancing their capabilities by design. This, for example, enables multi-scale optimization and manufacturing of, for example, ultra-lightweight structures consisting of optimized macro geometries and tailored lattices on a meso level. Combined with smart materials and deployables, such innovative concepts and designs are currently being investigated for upcoming robotic landers and rovers.

All of these new developments have been widely presented and discussed in this year's IAF Materials and Structures symposium confirming their high importance to the space community.

3. Future Outlook

Looking ahead, several topics in the field of materials and structures are on the horizon and about to drastically change some of the design and manufacturing approaches of classical space systems. From a technological point of view, the topic of in-space manufacturing is expected to open up unparalleled possibilities with respect to a sustained human space exploration. To enable off-Earth manufacturing, innovative additive manufacturing techniques are combined with in-situ resource utilization, which providing the fundamental ingredients from a materials perspective. In-space manufacturing is also of high importance for upcoming exploration missions to Moon and Mars and will therefore be heavily investigated and matured in the near future.

Another very promising but yet underdeveloped field is structural health monitoring. Understanding the health status of structures and systems while in use, unlocks unprecedented opportunities in terms of operation, prediction and design optimization of space systems. Only with the availability of increased computational power on-board of spacecraft (i.e. edge computing), real-time processing of structural health data of a satellite is possible. This revolutionary technology will enable significant autonomy and smartness of future space systems.

Finally, the paradigm of design-to-cost will gain more and more importance throughout all subsystems of a spacecraft. Therefore, the design and manufacturing of future space structures and materials will increasingly be driven by cost, schedule and the potential for large-scale serial production, especially for large-scale commercial space applications.

4. Committee activities

For next year, the committee plans to reorganize some sessions of its symposium to better respond to new developments taking place in the field of space technologies, materials and structures.