July 2021

IAF MATERIALS AND STRUCTURES COMMITTEE

1.Introduction/Summary

The IAF Materials and Structures Committee was established more than three decades ago. The Materials and Structures Symposium, coordinated by the Committee, provides an international forum for recent advancements in the assessment of the latest technology achievements in space structures, structural dynamics, and materials. Currently, the Materials and Structures Committee is made up of about 40 members, among which more than 30 are strictly involved in the annual organization of the IAC conferences.

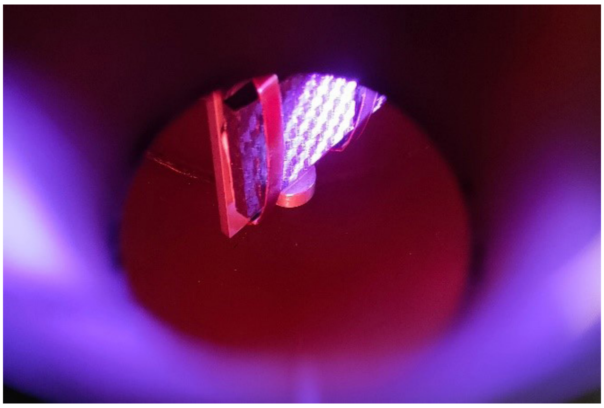
2. Latest Developments

Since its establishment, the Materials and Structures Symposium covers all the scientific aspects of the space sector: space vehicles and components, deployable and dimensionally stable structures, dynamics and microdynamics, advanced materials and structures for high-temperature applications, advancements in materials applications and rapid prototyping, space environmental effects and spacecraft protection, mechanical, robotic, thermal, fluidic systems, specia-lized technologies, including nanotechnology, smart materials and adaptive structures. The memories presented at the IAC Congresses have always reached a high number, so much so that the Symposium is one of the most followed within the IAC.

It is worth to mention also the increasing scientific collaboration between the various Committee's Members. This has allowed the development of new research activities between different Countries, as between the La Sapienza University of Rome in Italy and the Moscow Aviation Institute in the Russian Federation.

These links also allow us to tackle increasingly topical scientific issues, for example, a more in-depth study on the knowledge of extreme space environments, such as the LEO orbits but also of the lunar and martian environments. The study of the synergistic effects between Atox and UV rays, which can affect the radar visibility of satellites, is one of the themes on which the Symposium is involved.

Carbon/Carbon plate subjected to Atox and UV irradiation



3. Breakthroughs

One of the most significant trends that have been observed in recent years is linked to the possibility of being able to produce and assemble mechanical components of spacecraft in orbit. As is known, large reflectors, large antennas and solar panels are difficult to make and test on the ground. Due to the need to make them very light to reduce launch costs, these subsystems are unable to withstand static and/or dynamic loads associated with Earth's gravity. In-orbit production makes it possible to overcome these limits although, at the same time, it will require the study of new techniques and methodologies, possibly based on automated mechanical machining orbit, for the assembly and the following phases of verification and validation of the components made and for their subsequent maintenance during their operating lifetime.

The reduction of Space Transportation costs is an important point when considering the evolutions of Mega Constellations, the increase of use of the Low Earth Orbit and for missions to Moon and Mars. This cost reduction requires besides improvements of the propulsion systems efficiency and the increase of reusability of launcher stages, the increase of the performance through even more efficient structural materials and designs. The efficiency of structures is often expressed in the structural index. This is the most important index, but efficient thermal insulations will reduce propellant boil-off losses and by this increase the P/L performance as well. This is an important aspect especially for missions with long ballistic phases. Composite applications for cryogenic propellants is seen as a game-changer for future launchers. Tightness of the propellant tanks and LOX compatibility as well as new failure criteria to be mastered are some of the main challenges of the application of CFRP as material for cryogenic propellant tanks. Structural health monitoring will become more important for reusable launchers.

These seemingly very difficult challenges will require ever greater synergy among different disciplines of the applied space engineering. Materials science, construction techniques, based for example on on-orbit additive manufacturing, together with mechatronics and a better knowledge of the space environment will have to be an integral part of future aerospace industries that want to play a leading role in the new space economy. In the coming years, therefore, the developments in materials technologies and in the design techniques of structures for space applications will have to face these new challenges both from the point of view of fundamental and industrial research. It is also worth to mention the possible use of the AI technique to control robotic manipulators for autonomous in-space structure assembly in the context of future lunar missions.

4. Action plan for the year

For the current year, the Materials and Structures Committee will propose some initiatives to involve researchers and engineers from new emerging countries in the aerospace sector.

The Committee would like to organize a technical meeting or round table with people from the UAE working in the field of structures and materials right after the committee meeting.

Moreover, starting with the current conference, the Committee would like to set aside two or three-time slots for virtual presentations of research conducted by scientists from emerging countries who do not have sufficient funds to cover travel expenses to attend IAC conferences in person.