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# Space Flight

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Chapter 10

# Suborbital Flight: An Affordable and Feasible Option for Mexican Aerospace Development

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**Abstract**

Suborbital flights are a low-cost option for universities. To perform suborbital missions, it is necessary to design, plan, test, verify, and validate each and every one of the subsystems that integrate the payload without leaving the Earth. In Mexico, some experiments have been carried out since the 1990s to test communication systems in case of disaster and emergency. The Mexican Service Gondola (CSM) from 2015 to date has made suborbital flights in conjunction with the National Polytechnic Institute and the group of Protective Coatings Resistant to Thermal Changes and Cosmic Radiation (CRTCR) to test communication systems and glass-ceramic coatings. Suborbital flights are a great opportunity to explore the national territory and test new communication systems, structures, and materials.

**Keywords:** suborbital flight, mexican service gondola, mission design, communication systems, glass-ceramic coatings

## 1. Introduction

Every day, there are new advances in the space area, specifically in satellites. Each time it becomes more complex to access space, due to requirements, restrictions (mass, volume,

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structural, etc.), cost and regulations, integration tests, and orbit assignment. For this, suborbital flights have become a viable option for probes of nanosatellite systems [1]. A suborbital flight can exceed 100 km in height and will not orbit the earth; that is, it will not leave the Earth's atmosphere [2]. Therefore, suborbital flights are viable for testing various subsystems and segments that are composing picosatellite and nanosatellite systems [3]. A nanosatellite system is characterized by its mass (1–10 kg), and its geometry can be cubic (CubeSat) or cylindrical (TubeSat). It should be noted that these nanosatellites can be composed by units of 1 kg (1 U) up to 10 units (10 U) [4]. These characteristics allow you to adjust and perform specific experiments or test subsystems in a timely manner and recover the nanosatellite, only if it does not go into space [3]. In addition, one of the advantages of performing suborbital flights is that you have a wide range of launch platforms as rockets, UAVs, and stratospheric balloons to climb into the high atmosphere [5]. The stratospheric balloons are an affordable platform for uploading nanosatellites and allow measurements during the ascent (infrared and ultraviolet radiation, X-rays, gamma rays, photographic recognition, and video capture) [6]. It also allows testing deployable systems (parachutes) for recovery of payloads without major damage [3]. For all the above, in Mexico, suborbital flights have become an alternative for sensors, communication, attitude, electrical subsystems, new materials resistant to thermal changes and cosmic radiation, etc., and the most important thing is that the universities allow the formation of human resources in the space area.

## 2. Suborbital flight: a window into space

In terms of altitude, a suborbital flight is limited by the Kármán line, which is a line 100 km above sea level. The Fédération Aéronautique Internationale defines this limit because it is roughly the point where a vehicle flying fast enough to support itself with aerodynamic lift from the Earth's atmosphere would be flying faster than orbital speed [7]. The Kármán line covers the troposphere (until 20 km), the stratosphere (until 50 km), the mesosphere (until 85 km), and a little section of the thermosphere, which extends until 690 km. **Figure 1** shows some physical properties of the atmosphere vs. altitude; this demonstrates that suborbital flight implies interesting conditions to implement scientific experiments [8].

Perhaps, the most attractive characteristic of suborbital flight is its cost, which is very low in comparison with space flight. According to NASA, today, it costs $10,000 to put a pound of payload in Earth orbit [9]. However, it costs about $1000 per pound to make a suborbital mission and that includes launching, tracking, and recovering the payload.

## 3. Suborbital flight: historical panorama

Mexico has been entering the area of suborbital flights in the late 1990s. Since then, a group of amateur radio operators from the "Radio Club Satélite" has sent several high-altitude balloons for experimental communication projects such as TSAT-1, TSAT-2, TSAT-3, and TSAT-4

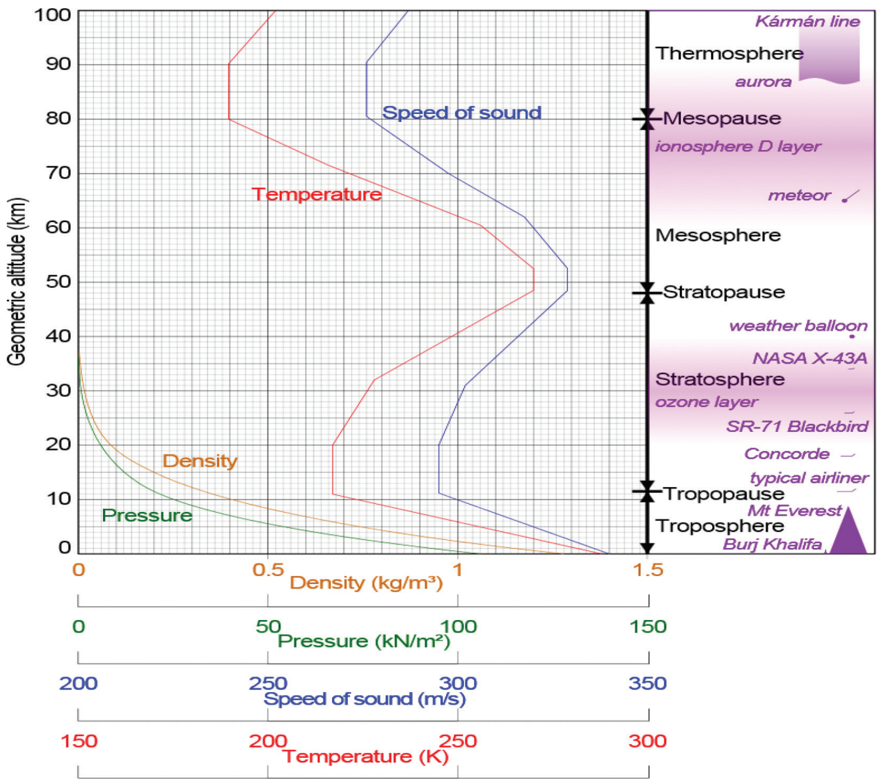


**Figure 1.** Comparison of the 1962 US standard atmosphere graph of geometric altitude against density, pressure, the speed of sound, and temperature with approximate altitudes of various objects [8].

and RCS-V, RCS-VI, RCS-VII, and RCS-VIII completing two test flights and eight full flights over the past two decades. In generally, flights only the RCS-V gondola was lost. The rate at recovery is over 90% owing to the use of onboard GPS that was not available at the time of the RCS-V project. The payloads were typically a 40 m band 4 W transmitter, 2 m band 0.7 W transmitter, altimeter, two temperature sensors, and a flight computer (**Figure 2**) [10].

In 2009, the CRAEG (Club de Radio Amateur del Estado de Guanajuato A.C.) launched their first project and one of the most complexes to date, SARSEM-ICARUS 1 (Mexican Aerostatic Subspace Repeater System). The objective of this project was to provide wide area communications in case of disaster or emergency for handheld and mobile VHF and UHF radios. The system carried a flight computer, a camera, temperature sensors, an onboard radio repeater, a dual GPS system, and a data communication system to download data and upload commands for controlling remotely specific subsystems. The gondola reached 28.8 km, had a radio coverage of 800 km, and was successfully recovered. In the following years (2010, 2011, 2013), SARSEM II, SARSEM III, and SARSEM IV were improved and redesigned, reaching their nominal altitudes and coverage as expected (**Table 1** and **Figure 3**) [11].

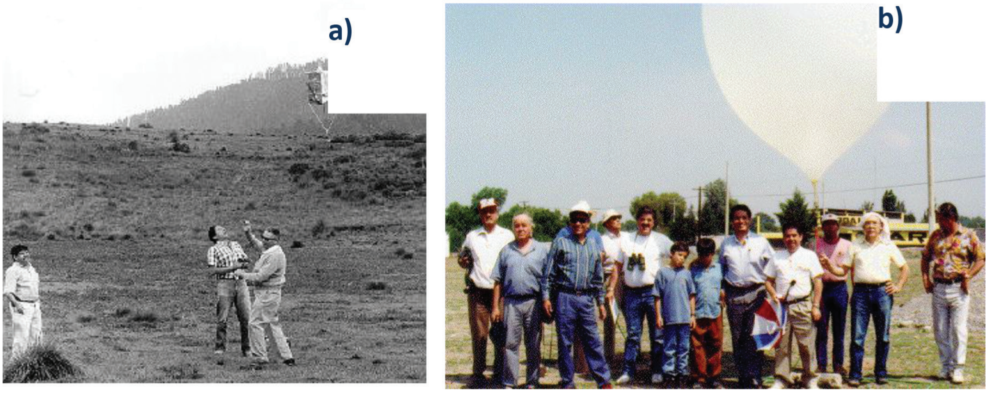


**Figure 2.** Projects (a) TSAT-1 (1992) and (b) RCS-V, RCS AC (1996).

| **Mission** | **Altitude (Km)** |
|---|---|
| SARSEM II (2010) | 28.7–800 km |
| SARSEM III (2011) | 33.6–900 km |
| SARSEM IV (2013) | 32.4–900 km |

**Table 1.** Mexican suborbital missions [11].

**Figure 3.** SARSEM-ICARUS III, CRAEG AC (2011).

## 4. Mexican missions: CSM

Following the achieved successes over the past two decades, the “Carga de Servicio Mexicana” (CSM) or Mexican Service Gondola was born in 2014. It should be mentioned that this project was initiated as a spin-off of the Pixqui payload which flew in a NASA gondola on August 2013 with the participation of the Engineering Faculty of the Institute of Engineering under the leadership of the Institute of Nuclear Sciences of the National Autonomous University of Mexico (UNAM) [12]. The idea was to build a suborbital platform to promote aerospace technologies by means of stratospheric flights between the altitudes of 25 and 35 km to test electronic systems and detectors used in satellites. This project followed the need to increment the aerospace technologies following the creation of the Mexican Space Agency around 2010, merging the effort of the national academic and industrial sectors [13]. From the start, the participation of undergrad and graduate students was considered essential for the future development of the technology in Mexico. It should be noted that suborbital platforms provide a cheap and easy-to-handle test facility based on sounding stratospheric balloons, which have flight durations of the order of a few hours. They are useful tools to test in near-space conditions of various aerospace systems and subsystems. In 2015 and 2016, two suborbital flights were successfully carried out over the state of Guanajuato, Mexico. A first gondola of 2.5 kg was launched, the CSM-1 housed one of the subsystems of Ulises 2.0, a nanosatellite developed by the Unidad de Alta Tecnología (UAT) of the Faculty of Engineering of the UNAM. It reached an altitude of nearly 31 km monitoring the thermal behavior of the electronic payload in addition to the temperatures inside and outside the gondola. This first experience was achieved because of a successful collaboration between the Institute of Engineering, the Engineering Faculty of the UNAM, the company, Remtronic Telecomunicaciones, and the Amateur Radio Club of the state of Guanajuato (CRAEG). The second gondola, CSM-2, with a weight of 2.1 kg, was an improvement of the first version, CSM-1, which had a crude structural design. Indeed, during the first flight, the gondola reached a velocity of about 8 m/s at landing despite the use of a parachute. The force of the impact deformed the structure, but the payload did not suffer any damages thanks to a custom-designed floating structure holding the payload inside the gondola. However, it appeared necessary to improve the impact absorbers, and a new design was tested during the second flight. This second flight carried two payloads, a monitoring atmospheric electronic system (SADM-1) and an experiment to try out a ceramic coating for satellites [14, 15]. Indeed, the new design allowed lowering the overall mass of the gondola while ensuring a better absorption at impact. This flight reached an altitude of 34 km. The external temperature of the gondola reached −70°C over a flight duration of about 2 h. For this second flight, the original collaboration included a new member, the National Laboratory for Additive Manufacturing, 3D Digitization and Computed Tomography (MADiT) of the Center of Applied Sciences and Technological Development (CCADET) of the UNAM. MADiT has strong capabilities and experience in design and manufacturing by means of additive manufacturing technologies. This national laboratory collaborates in the development of the structure of the gondola.

Part of the development of the gondola, CSM, a series of studies covering mechanical and thermal aspects have been conducted to improve the reliability of the structure and to diminish the risks, mainly associated with cold temperatures (<−60°C) and impact at landing [16, 17]. **Figure 4** shows a comparison between experimental and numerical values of the altitude of the balloon versus time of flight for both flights [17]. **Figure 5** is a photograph of the CSM-2 team just before the launch from the Explora Science Center, León, Guanajuato, Mexico, on November 2016. A new flight of CSM-2 is scheduled on April 2017 with additional clients.

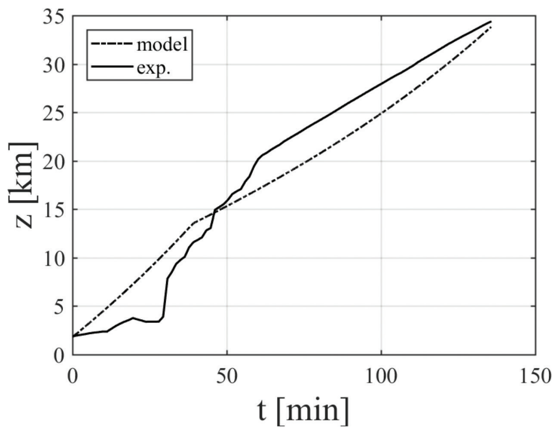


**Figure 4.** Comparison between the recorded altitude and the modeling one as a function of time [17].

**Figure 5.** CSM-2 team just before the launch of CSM-2 in November 2016 at the Explora Science Center, León, Guanajuato, Mexico.

The development of space technologies requires the use of stratospheric balloons since they offer a cheap, near-space environmental platform to test electronic systems of any kind. For the Mexican team developing CSM, it is the belief that it can lead to a sustainable development of the aerospace sector in the country involving the academic, governmental, military, and industrial sector. The first step has been carried out in that direction, and the future goal is to lift greater mass of a few tens of kilograms to improve the service already provided by CSM.

On the other hand, in Mexico, they have been designing glass-ceramic coverings to protect satellite systems of cosmic radiation and thermal changes. Aerospace materials must be lightweight and resistant to structural stresses, as well as to conditions in space [18, 19].

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In the manufacture of satellites, aluminum alloys maintain the leadership among lightweight and relatively low-cost structural metal materials, followed by alloys based on titanium [20, 21] for their low density and high resistance to corrosion.

Glass-ceramic coatings have proven to be a key technology in thermal stability and protection coatings in extreme environments such as aerospace gas turbines, which together with the engine operate at high temperatures (1370–1425°C) [22, 23]. So, the selection of materials for thermal barrier coatings is restricted by some basic requirements: (1) high melting point of the ceramics, (2) they must not present phase transformation between the ambient temperature and the operating temperature, (3) low thermal conductivity, (4) chemically inert in space environment, (5) the thermal expansion must be related to that of the metallic substrate,

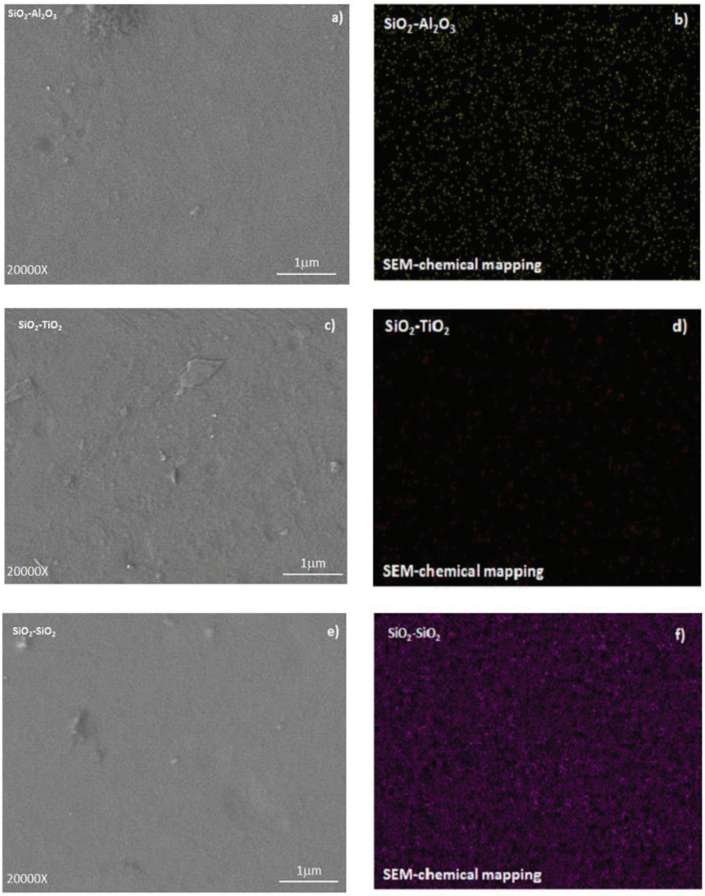


**Figure 6.** SEM images coatings: (a) $SiO_2$-$Al_2O_3$ surface, (b) $SiO_2$-$Al_2O_3$ chemical mapping, (c) $SiO_2$-$TiO_2$ surface, (d) $SiO_2$-$TiO_2$ chemical mapping, (e) $SiO_2$-$SiO_2$ surface, and (f) $SiO_2$-$SiO_2$ chemical mapping.

(6) good adhesion to the metallic substrate, and (7) low heating rate during the sintering process [24, 25]. The materials that can be used as glass-ceramic coatings is very limited; so far, only some materials have been found that meet these requirements [26]: aluminum oxide ($Al_2O_3$), mullite ($3Al_2O_3$-$2SiO_2$), cordierite ($2MgO$-$2Al_2O_35SiO_2$), zirconium oxide ($ZrO_2$), and zirconia stabilized with yttrium ($ZrO_2$-$Y_2O_3$). These coatings have been initially proposed for use as thermal control surfaces in aircraft because lightweight coatings with good adhesive properties can be obtained under thermal shock conditions [27]. This is why it could be considered that glass-ceramic coatings applied in satellite systems could resist ultraviolet, cosmic, and high-energy particles over a wide temperature range [28].

Therefore, the team of Coatings Resistant to Thermal Changes and Cosmic Radiation (CRTCR) from Space Science and Technology Network (REDCyTE) has designed glass-ceramic coatings reinforced with nanometric ceramic particles of $Al_2O_3$, $SiO_2$, and $TiO_2$, to obtain a multilayer system that is highly reflective and thin and homogeneous through the sol-gel. **Figure 6** shows images of scanning electron microscopy (SEM) in topography mode, in which the surfaces of the coatings are shown. In the same figure, SEM images are shown in chemical mapping mode in which the uniform dispersion of the ceramic nanoparticles immersed in the vitreous matrix is shown.

## 5. Challenges in medium and long term

In 2010, the Mexican Space Agency was born [29]. It followed a few decades of academic work and the need for an institution to formalize and federate projects toward the development of national space technologies. In 2015, a specific fund allocated to space technology was created by the government through the Federal Funding Agency (CONACYT) [30]. A few projects have been so far benefitting from this fund, and among them, one project dedicated to suborbital flights using stratospheric balloon was funded (ATON) [30]. Unfortunately, it was the only project funded to promote suborbital flights, and it is clear that more incentives are needed to allow the development of this sector in a near future and also to sustain the development of the space technologies in Mexico. In medium term, one can prospect for a need to increase the gondola size to provide services to larger payloads with greater mass. Typical light payloads range from less of a few kilograms to tens of kilograms. To lower the cost of flights and provide a service throughout the year, it is essential to be able to carry up to a ton if not a few hundreds of kilograms. At those masses, the risk associated with structural damages and health safety that such a gondola can create in semi-urban centers is too high. Therefore, flights over the oceans or the deserts, both available in Mexico, should be planned under the resources of the marine, air force, and the government for proper permits. It seems unlikely that flights over the jungle as one could plan in south of Mexico is realistic, due to the complexity to recover a gondola in a harsh, difficult-to-access environment with dense vegetation. States such as Sonora, Chihuahua, and Durango for desert lands or Baja California, Sinaloa, and Veracruz for oceans can be explored as possible sites for launches. Additionally, specific balloons of larger flight durations should be investigated and tried out in conjunctions with large masses of a few hundreds of kilograms to a ton.

Besides the practicability of the launch, tracking and recovery of the gondola, and the payload, it is important that the structure, which the gondola offers, houses onboard electronics and power services. The system should be able to monitor the environment and itself and to supply the payloads with the necessary power for their operation. Multidisciplinary teams of engineers in mechanics, aerospace technology, telecommunication, electrical and electronic systems, and aeronautics should be part of this effort, and likely a national center for aerospace technology can be the right place to gather those specialties. There is an important risk that allocating resources to small individual projects may not be fructuous on the long term and it may be sensible to lay out one or a couple of projects of national interest that can lead the effort with a sustainable funding.

## 6. Conclusions

Mexico has been involved into suborbital flights since the past two decades through amateur impulse. Lately, the academic sector has been starting to promote the use of stratospheric sounding balloons to provide the scientific and technological communities and inexpensive, easy-to-use facility to test their aerospace technologies. A few suborbital flights over the country have been carried out by different institutions with a large participation of students. Among the different projects, CSM is the only one involving mostly researchers and engineers from the academic and private sectors with the objective to professionalize this area of knowledge following the example of leading countries. This platform has provided two flights of 2-h duration for altitudes over 30 km to three clients. It is expected to provide yearly flights to future clients accommodating payloads of larger masses.

Overall, suborbital flights are the first step for Mexico to get involved in the aerospace development. Increasing funding, engineering schools, and national laboratories dedicated to aerospace studies and technological and scientific projects with the participation of the government, the military and the private sector is considered mandatory to achieve a significant contribution to the field in Latin America.

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## References

[1] Welti CR. Satellite Basics for Everyone. Blomington: iUniverse, Inc.; 2012. pp. 10-16

[2] Thom Stone, Marcus Murbach, Richard Alema, Ray Gilstrap. SOAREX- Suborbital Experiments 2015 – A New Paradigm for Small Spacecraft Communication. In: Aerospace Conference 2015. Montana, USA: IEEE

[3] Sako N, Tsuda Y, Ota S, Eishima T, Yamamoto T, Ikeda I, Li H, Yamamoto H, Tanaka H, Tanaka A, Nakasuka S. Cansat suborbital launch experiment-university educational space program using can sized Pico-satellite. Acta Astronautica. 2001;**48**(5-12):767-766

[4] Briess K. Space design process. In: Ley W, Wittmann K, Hallmann W, editors. Handbook of Space Technology. 1st ed. United Kingdom: Jonh Wiley and Sons, Ltd; 2009

[5] Selva D, Dingwall B, Altunc S. A concept for an Agile Mission Development Facility for Cubesat and suborbital Missions. In: Aerospace Conference. Montana, USA: IEEE; 2016

[6] Antunes S. DIY Instruments for Amateur Space. 1st ed. California, USA: O'Reilly Media Inc.; 2013

[7] Sanz Fernández de Córdoba S. Karman separation line, used as the boundary separating Aeronautics and Astronautics. Fédération Aéronautique Internationale; 2004. https://

www.webcitation.org/618QHms8h?url=http://www.fai.org/astronautics/100km.asp [accessed: 12/10/2017]

[8] Advanced Space Transportation Program: Paving the Highway to Space, Marshall Space Flight Center, NASA. Available from: https://www.nasa.gov/centers/marshall/news/background/facts/astp.html [Accessed: Dec 11, 2017]

[9] U. S. Centennial Commission. Geometric altitude vs. temperature, pressure, density, and the speed of sound derived from the 1962 U.S. Standard Atmosphere. http://www.centennialofflight.net/essay/Theories_of_Flight/atmosphere/TH1G1.htm [Accessed: 12/07/2017]

[10] Solana J. Radio Club satellite A.C. BOLETIN XE1RCS. Historical Achieves (2008-2015). Mexico; 2017

[11] Club de Radio Amateur del Estado de Guanajuato A.C.-XE1CRG. Historical Archives (2009-2015). Guanajuato, Mexico; 2017

[12] CONACYT Press. Pixqui: plataforma mexicana de pruebas satelitales, Aug 18 2015. Available from: www.conacytprensa.mx [Accessed: Aug 11, 2017]

[13] Agencia Espacial Mexicana (AEM) Antecedentes de la AEM. Available from: www.gob.mx/aem/acciones-y-programas/antecedentes-de-la-aem [Accessed: Apr 12, 2017]

[14] Mendoza Bárcenas MA, Prieto Meléndez R, Santiago Cruz L, Trillaud F, Espinosa Calderón A, Herraiz Sarachaga M, Velázquez Villegas F. Módulo experimental de carga útil "SADM-1" para fines de exploración atmosférica. Sociedad Mexicana de Instrumentacion. In: XXXII Congreso de Instrumentación. Guerrero, Mexico; October 2017

[15] Herrera-Arroyave JE, Bermúdez-Reyes B, Ferrer-Pérez JA, Colín A. CubeSat system structural design. In: 67th International Astronautical Congress. Guadalajara, Mexico; September 2016. pp. 1-5

[16] Sebastian Rosas Contreras. Diseño de la Estructura Mecánica de una Carga de Servicio Ligera de Globos Estratosféricos Nacionales [undergraduate thesis]. UNAM; Oct 1, 2016

[17] Singer Genovese R, Trillaud F, Velazquez Villegas F, Santiago Cruz L, Remba J. Model and simulations of high altitude sounding balloons: Dynamics, stress-strain and thermal analysis. In: 67th International Astronautical Congress. Guadalajara, Mexico; Sep 2016. pp. 1-11

[18] DiCarlo JA, Yun H-M. Non-oxide (Silicon Carbide) Fibers. In: Bansal NP, editor. Handbook of Ceramics Composites, NASA Glenn Research Center. United States of America: Kluwer Academic Publisher; 2005. pp. 33-38

[19] ECSS Secretariat ESA-ESTEC. Space Engineering. Structural Materials Handbook. Part 4: Integrity control, verification guidelines and manufacturing. European Cooperation for Space Standardization. Noordwijk, The Netherlands: Requirements & Standards Division; 2011. pp. 219-230

[20] ASM International, editor. Metals Handbook. Vol. 2. Properties and Selection: Nonferrous Alloys and Special Purpose Materials. 10 ed. Metals Park, OH: ASM; 1999

[21] Hussey R, Wilson J, editors. Light Alloys Directory and Handbook. London: Chapman and Hall; 1998

[22] Berndt CC, Brindley W, Goland AN, Herman H, Houck DL, Jones K, Miller RA, Neiser R, Riggs W, Sampath S, Smith M, Spanne P. Journal of Thermal Science and Technology. 1992;**1**:1

[23] Cortese B, Caschera D, de Caro T, Ingo GM. Micro-chemical and -morphological features of heat treated plasma sprayed zirconia-based thermal barrier coatings. Thin Solid Films. 2013;**549**:321-329

[24] Cernuschi F, Bianchi P, Leoni M, Scardi P. Thermal diffusivity/microstructure relationship in Y-PSZ thermal barrier coatings. Journal of Thermal Spray Technology. 1999;**8**(1):102-109

[25] Vassen R, Tietz F, Kerkhoff G, Stoever D. New materials for advanced thermal barrier coatings. In: Lecomte-Beckers J, Schuber F, Ennis PJ, editors. Proceedings of the 6th Liége Conference on Materials for Advanced Power Engineering. Belgium: Universite de Liege; Nov 1998

[26] Cao XQ, Vassen R, Stoever D. Ceramic materials for termal barrier coatings. Sciencie Direct, Journal of European Ceramic Society. 2004;**24**:1-10

[27] Singletary BJ. Ceramics, Refractories and Glasses. In: Rittenhouse JB, Singletary JB. editors. Space Materials Handbook. 3rd ed. United States of America: NASA SP-30 51; 1969. pp. 120-130

[28] Nguyen CH, Chandrashekhara K, Birman V. Multifunctional thermal barrier coating in aerospace sándwich panels. Mechanics Research Communications. 2012;**39**:35-43

[29] Consejo Nacional de Ciencia y Tecnología. Comunicado 64/14, Invertirán CONACYT y Agencia Espacial Mexicana más de 30 MDP en investigación e innovación aeroespacial. Ciudad de México, Oct 8, 2014. Available from: https://www.conacyt.gob.mx/index.php/comunicacion/comunicados-prensa/381-invertiran-conacyt-y-agencia-espacial-mexicana-mas-de-30-mdp-en-investigacion-e-innovacion-aeroespacial [Accessed: Dec 16, 2017]

[30] Consejo Nacional de Ciencia y Tecnología. Agencia Informativa, Montserrat Muñoz. Misión suborbital ATON – Ulises I: Ciencia y arte en la FIL. Dec 7, 2015. Available from: http://www.conacytprensa.mx/index.php/ciencia/universo/4619-prioritaria-mision-suborbital-aton-ulises-i-ciencia-y-arte [Accessed: Apr 12, 2017]