Indian National Society for Aerospace and Related Mechanisms
BANGALORE CHAPTER

E-NEWSLETTER

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From the Editor

Dear Member,

The SARAL spacecraft was launched in February 2013 and the two solar array deployment mechanisms developed by the Spacecraft Mechanisms Group, ISAC were deployed successfully in orbit. The editorial committee congratulates the members of Spacecraft Mechanisms Group, ISAC for this excellent achievement. With this the Spacecraft Mechanisms Group completed 150 successive successful on-orbit deployments. The editorial committee congratulates the past and the present members of Spacecraft Mechanisms Group, ISAC for their contributions towards this achievement.

The 8th National Seminar on Aerospace Related Mechanisms was held in ARDE, Pune in December 2013. Several members of INSARM Bangalore Chapter presented technical papers. One of papers written by the ISARAM members bagged the award for oral presentation. The editorial committee congratulates the authors for their excellent achievement. The first article of this issue of news letter gives the details of the award winning paper for the information of the members. Another article titled *"Secondary treatment options for various materials used in space mechanisms"* presents the use of secondary treatments like anodizing, dry lubrication, different coating and other treatments to enhance the hardness, corrosion resistance and other properties.

In January 2013, INSARM, Bangalore Chapter organized a guest lecture on "*Strain Gage Technology*" at ISRO Satellite Centre, Bangalore by Sri. S. Raviprakash, MD & CEO, Pyrodynamics. Bangalore, The seminar was well attended and appreciated.

This news letter is intended to be a platform for the exchange of information regarding the current developments, new ideas and novel concepts in the area of mechanisms and related field through active participation of members. I request all INSARM members to actively contribute technical articles related to mechanisms to enhance the technical value of the e-new letter.
With best regards,

Dr. B.P. Nagaraj
Chief Editor

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Quote:

"Innovation comes only from readily and seamlessly sharing information rather than hoarding it."

By Tom Peters

INSARM BANGALORE CHAPTER

NEWS

DESIGN OF THREE UNIQUE TYPES OF HOLD-DOWN MECHANISMS FOR CLAMPING OF A SPACECRAFT ANTENNA

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INTRODUCTION

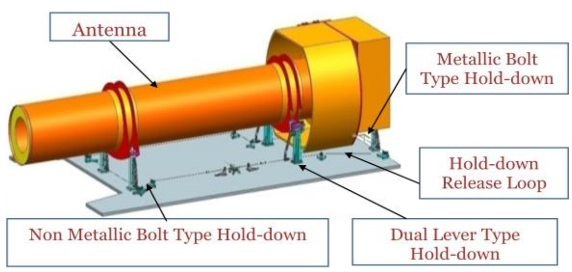
Three type of hold down technologies employed for clamping of a large antenna to spacecraft with the use of minimum/no metallic (for RF Transparency) components on the antenna after deployment and ensuring positive release are developed

CONFIGURATION

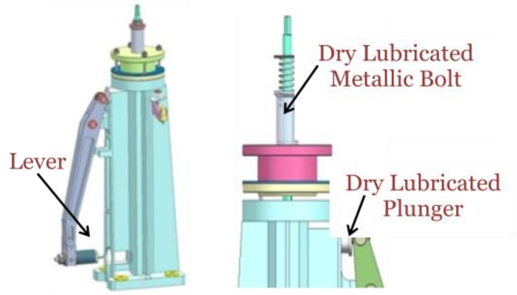
- In the metallic bolt type holddown dry lubricated bolt or non metallic bolt and plunger gets engaged in the tapered recess to preload the holddown.
- In the dual lever type hold-down, the horizontal lever directly clamps the hold-down through a spherical seating. This ensures the load path is maintained along the hold-down axis.

Load values for design of the hold-downs	
Description	**Load /Details**
Mass (Payload and mechanism)	40kg
Preload for the hold-downs	350kgf
Lever ratios	1:6 for Metallic bolt type 1:8 for Dual lever type 1:6 for Non metallic bolt type

Antenna Clamping Configuration



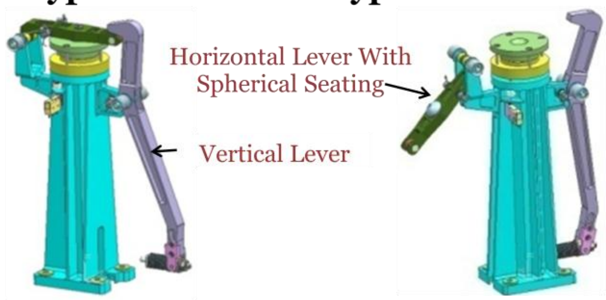
Type-1: Metallic bolt type holddown



Salient Features

- Higher design margin
- Minimum space
- Most consistent and measurable preloads

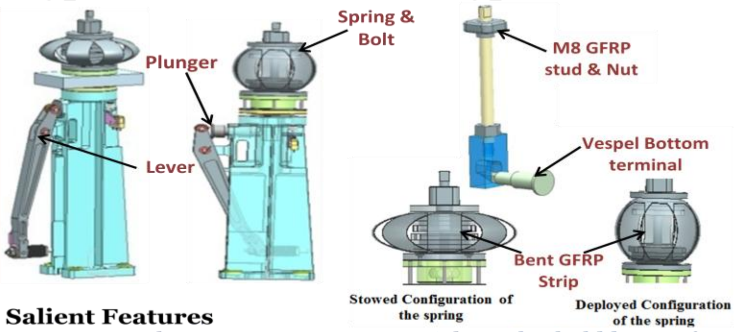
Type-2: Dual lever type holddown



Salient Features

- High Mechanical advantage
- Leaves only RF transparent material on the holddown after deployment.

Type-3: Non metallic bolt type holddown



Salient Features

- Leaves only RF transparent material on the holddown after deployment.

CONCLUSIONS

Each holddown has unique clamping capability. Use of modular and common loading configuration enables them to be used as singular holddown and also in tandem. Long vertical levers ensure high mechanical advantage in each design. Novel dual lever and non metallic bolt type holddowns can be used with no RF interference.

SECONDARY TREATMENT OPTIONS FOR VARIOUS MATERIALS USED IN SPACE MECHANISMS

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Spacecraft mechanisms are subjected to severe environments during their launch phase and also after being injected into the space. Remote sensing spacecrafts are injected into Low Earth Orbits (LEO) where spacecraft mechanism along with Satellite has to face several thermal cycling because satellite enters and comes out of eclipse once in every orbit. They have a life of around 4 to 5 years and mechanisms are supposed to perform thought out the life cycle of the missions. Geostationary spacecraft in Geostationary orbits face extended cooling phase or heating phase depending on their relative position with respect to the Sun. Vacuum conditions in both the orbits are the same.

Secondary treatment to the material used in space is provided to enhance the inherent surface characteristics. Many such treatments are also provided to prepare the surface for the application of other treatment. Secondary treatment forms a major part of the complete realization process because they are implemented to meet very specific requirements. Treatments related to the spacecraft mechanisms are implemented to serve several purposes such as to enhance the hardness of the surface, corrosion resistance, thermal requirements on orbit or to reduce the friction between the relative moving parts. Table 1 summarizes the major objectives for the implementation of the particular treatment.

Table 1: Objectives of Different Secondary Treatments

SL No.	Secondary Treatment	Objectives
1.	Anodisation	• To enhance the thermal absorptivity and emissivity(α and ε) • Surface preparation for dry lubrication • To enhance corrosion resistance.
2.	Hard Anodisation	• To enhance the surface hardness thus increasing the wear resistance capacity due to surface contact.
3.	Sand Blasting	• Surface preparation for dry lubrication
4.	Dry lubrication i) Bonded film MoS_2 coating ii) Sputtered MoS_2 coating	• To reduce the friction between the relatively moving components • To avoid cold welding between the components in contact • Sputtering is done to avoid debris formation
5.	Gold plating	• To enhance the electrical conductivity and lubrication
6.	Stress relieving	• To reduce the internal residual stresses developed during machining
7.	Passivating	• To make the material chemically inert
8.	Hardening	• To enhance the strength and dimensional stability
9.	Sodium Silicate coating(Na_2Sio_3)	• To retain Kevlar fiber together and avoid brooming
10.	Thick film coating	• To imprint with resistive elements on ceramic base to make high temperature heaters (800^0-900^0C) or resistors
11.	Thin film coating	• Physical vapour deposition (PVD) of resistive layer on ceramic base to make high temperature heaters (800^0-900^0C)

These secondary treatments include several heat treatment processes and surface coating. By experimental methods and experience the layer thickness formed and their effect can be summarized in Table 2. The chart 1 presents the processes which were implemented on various materials.

Table 2: Layer Thickness in Secondary Treatment

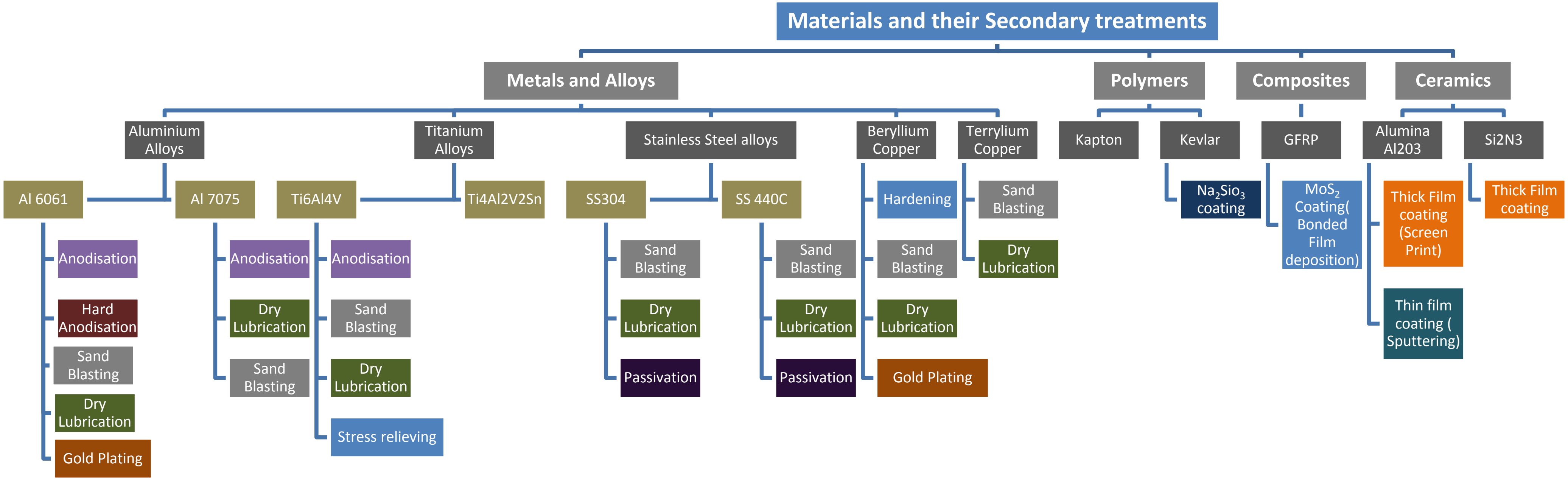
Sl No	Secondary treatment	Layer thickness	Remarks
1.	Anodisation	15-20µm	
2.	Hard Anodisation	50-70µm	
3.	Sand Blasting	Ra(roughness) = 1-3 µm	
4.	Dry lubrication		
4a	Bonded film MoS_2 coating	5-10µm	µ < 0.3 (on ground)
4b	Sputtered MoS_2 coating	1-2 µm	
5.	Gold plating	≥ 5 µm	
6.	Sodium Silicate coating(Na_2Sio_3)	Soak deposition	Thickness not measured
7.	Thick film coating	20-65 µm	
8.	Thin film coating	3 µm(max)	
9.	Stress relieving	-	550^0C for 1hr & furnace cooled
10.	Passivating	-	Visual Inspection
11.	Hardening	-	Yield stress improves to 128kgf/mm^2

It may be noted that there may be many processes that can be implemented for the improvements of the properties but in this article the concentration is kept on the processes being carried out on materials used in spacecraft related mechanisms. These processes have been successfully used for the on-orbit mechanism components.

References:

1. Parts and process specification document Vol 1 and Vol 2. MATD/SMG/ISAC/ISRO, July 2002
2. Department of Defense Handbook, Metallic material and elements for Aerospace related structures, Department of Defense USA, MIL- HDBK-5H December 1998.
3. Material Selection and Applications in Mechanical Engineering, by A Raman. Industrial Press Inc. , First Edition 2007

SECONDARY TREATMENT OPTIONS FOR VARIOUS MATERIALS USED IN SPACECRAFT MECHANISMS



Congratulations to the Spacecraft Mechanisms Group, ISAC for Completing 150 successive successful on orbit deployments on spacecraft

FORTH COMING SEMINARS

1) International Conference on Advances in Robotic, Mechanical Engineering and Design
Aug 01-02, 2013 at Chandigarh, India
Link: ***http://armed.theides.org/2013/***

2) International Conference on Smart Technologies for Mechanical Engineering
25-26 Oct 2013, Delhi Technical University, Delhi, India
Link: ***http://stme2013.org/***

INVITATION FOR ACTIVE PARTICIPATION

We invite you to send technology news, technical articles, members' news and suggestions/comments on e-newsletter and the web contents to Chief Editor to improve the newsletter. The technical articles may be limited to 400 words only in MS Word format with two photographs. The direct extracts from references may be avoided. Kindly provide your e-mail & mail address to enable us to contact you.

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