Indian National Society for Aerospace and Related Mechanisms

BANGALORE CHAPTER

E-NEWSLETTER

Vol. 2, NO. 2, May 2008

From the Editor

Dear Member,

It has been indeed a very eventful quarter for the INSARM mechanisms community. With the deployment of the two solar panel wings on Cartosat-2A spacecraft on 28th April, 2008, the Spacecraft Mechanisms Group, ISAC, has completed 100th successively successful deployments on-orbit. The editorial committee congratulates the past and present members of the Spacecraft Mechanisms Group for this commendable achievement. The list of the on-orbit deployments right from IRS - 1A to till date, totaling 104 deployments, are brought-out in this issue of the newsletter.

During the sixth national seminar on Aerospace and Related Mechanisms at ARDE, Pune, in March 2008, two papers written by members of the Spacecraft Mechanisms Group, ISAC, bagged awards, one for oral presentation and the second for the poster presentation. The editorial committee congratulates the authors of the two papers for this excellent achievement. This issue of the e-newsletter carries the extended abstracts of the award wining papers for the information of the members.

It may be brought to your notice that the purpose of this newsletter is to be a medium of information exchange regarding the state of the art developments and future directions in the area of mechanisms and related fields. The editorial committee solicits your active participation in the form of technical articles and ideas which will certainly enhance the technical value of this e-newsletter.

With best regards,

Dr. R Ranganath
Chief Editor

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FROM INSARM BANGALORE CHAPTER

Forthcoming conference/seminars

5th ISSS International conference on Smart materials, Structures and Systems
At IISc, Bangalore, on 24-26 July 2008.
www.isss.in

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INSARM BANGALORE CHAPTER

NEWS

ARMS 2008 2ND BEST PAPER AWARD IN ORAL PRESENTATION

STATIC AND DYNAMIC ANALYSIS OF REFLECTOR DEPLOYMENT MECHANISM

HN Suresha Kumar, HS Vijayalakshmi, B Lakshminarayana and BS Nataraju
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Abstract:

A typical communication satellite is configured to have two antenna reflectors, mounted on the East and West sides of the spacecraft. These reflectors are stowed during launch and deployed in orbit. The holddown/release mechanism holds the reflectors during launch and releases the same on-orbit. The deployment mechanism ensures rotation of the reflector about its hinge axis and latching-up in the intended final orientation. The deployment mechanism for each reflector consists of two hinge assemblies and two hold-down assemblies to clamp the reflector on the East/West faces of the S/C. The mechanism is subjected to dynamic loads during launch and latch-up-shock loads at the end of the deployment. The launch loads are shared by hold down and hinge assemblies and latch-up shock loads are withstood by hinge assemblies.

A mathematical model of the reflector deployment mechanism has been developed using MSC PATRAN. This includes the finite element modelling of different constituents like hinge brackets, holddown assembly, locking linkage etc. These have been appropriately positioned on a spacecraft model, simulating the stowed configuration of the reflector on spacecraft. The finite element model of the reflector provided by the reflector manufacturer has been integrated with this to obtain the full mathematical model of the system. A schematic of the same has been provided in Figure-1. All the individual constituents have been connected together with the help of rigid beam elements. The requisite boundary conditions at hinges and holddown assemblies have been simulated.

Detailed analysis activities have been carried out using the above mathematical model of the system. The software NASTRAN has been used for the analysis. Initially, normal mode analyses on each of the subassemblies have been carried out to validate the corresponding mathematical model. Each of these subassemblies has been systematically integrated and at each stage, the normal mode analysis has been carried out to validate the mathematical assembly. The normal mode analysis on the full assembly provides useful design inputs like the natural frequencies, mode shapes, participating masses etc., Static analysis have been carried out on the stowed assembly, simulating the launch acceleration loads.

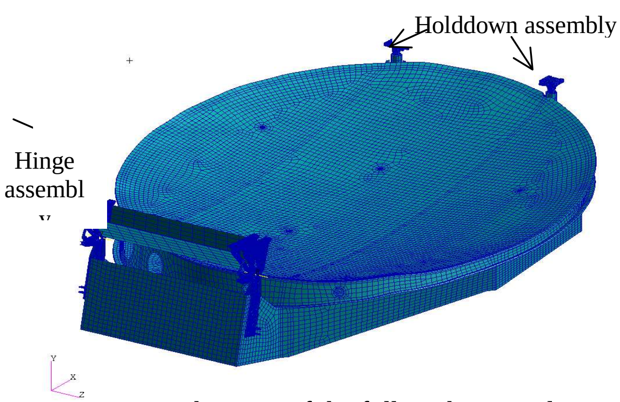

Figure-1 Schematic of the full mathematical

A deployment dynamics study has been carried out using the software ADAMS. The hardware characteristics of different constituents have been simulated (Figure-2). The results from the deployment dynamics study include determination of deployment time and latch-up velocity for on-orbit and simulated ground deployment conditions. This also provides inputs for deployment shock analysis.

Further, the finite element idealization of deployed configuration has been simulated. A normal mode analysis has been carried out to determine the deployed natural frequency of the system. Static analysis has also been carried out on the deployed assembly, simulating the latch-up shock loads. This analysis provided design inputs like reaction forces and moments at different interfaces. Latch-up shock analysis has been carried out to estimate the latch-up moment loads on the hinge line.

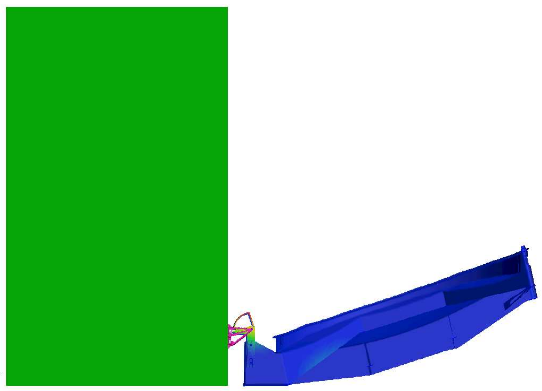

Figure-2 Deployment dynamics study

Subsequently, reduced mathematical models for hinge and holddown assemblies have been developed using Craig-Bampton technique. These are integrated with the finite element model of the reflector and the above activities have been repeated. A good match of results between reduced model results and full model results have been observed. The paper presents details of the above analysis activities.

Forthcoming conference/seminars (Continued from page 1)

International Conference on Aerospace Science & Technology

At NAL, Bangalore, on 26-28 June 2008.

www.nal.res.in/nal50/incast

International Conference on Trends in Product Life Cycle, Modelling, Simulation and Synthesis PLMSS-2008

At NAL, Bangalore, on17-19 November 2008

www.nal.res.in/nal50/plmss08

www.cpdm.iisc.ernet.in/plmss08

International Conference on Adavances in Armament Technology

At ARDE, Pune, on 20-22 November 2008.

www.icaat.in

ARMS 2008 2ND BEST PAPER AWARD IN POSTER PRESENTATION

Design and Development of Mixing Reactor for Bio-mimetic Synthesis under Microgravity on-board first Indian Spacecapsule Recovery Mission

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[2] National Metallurgical Laboratory, Jamshedpur 831 007, India

ABSTRACT

There is considerable interest worldwide to conduct microgravity experiments in space and making them commercially viable. Due to unique condition offered by space, there are many processes, materials and products that are possible to make in space which otherwise not possible on earth. For example life savings drugs (inter-pheron for cancer treatment), bioactive products, perfect crystal, perfect sphere and container-less heating etc. Many space faring nations have conducted microgravity experiments on unmanned recoverable satellite systems. Indian Spacecapsule recovery mission, which successfully recovered microgravity experiments, was one such attempt in this field.

The paper describes the design details of this module considering the constraints such as mixing of two reactants only after reaching the orbital microgravity condition, reliable actuation and ensuring mixing under microgravity, and no leakage under space environment. A pyro-operated mechanism with glass as the separation wall was conceived and built. Provisions are made for pyro-cutter actuation onboard by pyro firing package and telemetry of actuation signal to ground.

Figure 1: Mixing Reactor on-board S/C

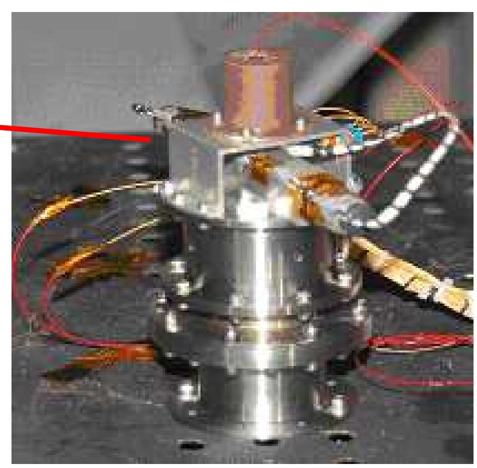

Figure 2: Liquid Mixing Reactor-Qualification Model

The reactor is successfully used for bio-mimetic synthesis (payload) of hydroxiapatite nanoparticles under micro gravity environment on ISRO's Recovery Mission (Figure-1). The objective of this experiment was to study the biomimetic synthesis of hydroxiapatite nanoparticles under micro gravity environment. For this space processed sample in mixing reactor was planned to compare with ground experiment results. In this experiment a liquid diammonium hydrogen phosphate and Ca-ion loaded PVA-collagen mixture (a bio-mimetic gel) were placed in the reactor and experiment was conducted by actuating mechanism. The study of space processed samples received from reactor after recovery of S/C suggests,

a) Almost all the liquid and gel have reacted i.e. full volume of sample is processed and reaction is completed.
b) The morphological features through out sample are similar.
c) These features are found different from that obtained from ground experiment.

This paper highlights realisation of a mixing reactor and the glass breaking mechanism to allow the mixing of two liquids or liquid with semi solid/ gel for an unmanned recovery satellite.

The reactor specifications are as follows,

Parameter	**Description**
Size	Diameter-100 mm, Height-185 mm
Reaction chamber Volume	100 cc (Liquid to Gel ratio allowed upto 4:1)
Vacuum sealing (Leak rate)	$1x10^{-6}$ Std CC/sec
Mass	2.3 Kg
Mechanical I/F with SRE S/C	8 holes X Dia 4.5 mm at 70 PCD on lower cylinder flange
Electrical I/F	9 Pin connector, for telecommand from electro-explosive electronics
T/M Interface	1 Bit telemetry Provision

Figure 3: Mixing Reactor after recovery

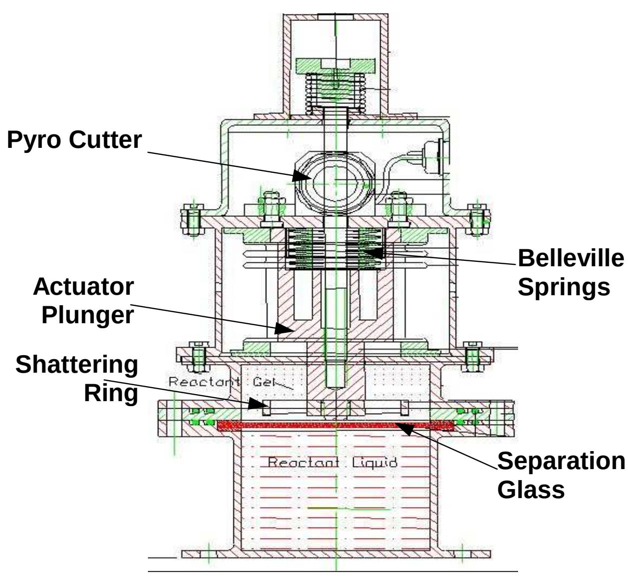

Figure 4: Bio-mimetic Payload Reactor Mechanism

MECHANISMS: A CENTURY OF SUCCESSIVE SUCCESSES & BEYOND ....

SPACECRAFT MECHANISM GROUP, ISRO SATELLITE CENTRE

Sl No	Name of Satellite	Mechanism for Deployment of	Launch Date	No. of Deployments	
				Individual	Cumulative
1	IRS – 1A	Solar Array SS Wing Solar Array ASS Wing	17-03-1988	2	2
2	IRA – 1B	Solar Array SS Wing Solar Array ASS Wing	29-08-1991	2	4
3	INSAT – 2A	Solar Array Main panels Solar Array Side panels East Reflector West Reflector Sail/Boom	10-07-1992	5	9
4	INSAT – 2B	Solar Array Main panels Solar Array Side panels East Reflector West Reflector Solar Sail/Boom	23-07-1993	5	14
5	IRS – P2	Solar Array SS Wing Solar Array ASS Wing	15-10-1994	2	16
6	INSAT – 2C	North Solar Array South Solar Array East Reflector West Reflector	07-12-1995	4	20
7	IRS – 1C	Solar Array SS Wing Solar Array ASS Wing Pan Camera	28-12-1995	3	23
8	IRS – P3	Solar Array SS Wing Solar Array ASS Wing	21-03-1996	2	25
9	INSAT – 2D	North Solar Array South Solar Array East Reflector West Reflector	04-06-1997	4	29
10	IRS – 1D	Solar Array SS Wing Solar Array ASS Wing Pan Camera	29-09-1997	3	32
11	INSAT – 2E	Solar Array Solar Flaps (2Nos) East Reflector West Reflector Solar Sail/Boom	03-04-1999	6	38
12	IRS – P4	Solar Array SS Wing Solar Array ASS Wing OCM Tilt Mechanism	28-05-1999	3	41
13	INSAT – 3B	North Solar Array South Solar Array East Reflector West Reflector	22-03-2000	4	45
14	GSAT – 1	Solar Array Solar Sail/Boom West Reflector Antenna Pointing Mech.	18-04-2001	4	49
15	TES	Solar Array SS Wing Solar Array ASS Wing	22-10-2001	2	51
16	INSAT - 3C	North Solar Array South Solar Array East Reflector West Reflector	24-01-2002	4	55

17	KALPANA - 1	Solar Array	12-09-2002	1	56
18	INSAT – 3A	Solar Array Main panels Solar array Side Panels Solar Flaps (2Nos.) East Reflector West Reflector Solar Sail/Boom	10-04-2003	7	63
19	GSAT – 2	North Solar Array South Solar Array West Reflector SOXS Mechanism	08-05-2003	4	67
20	INSAT – 3E	North Solar Array South Solar Array East Reflector West Reflector	28-09-2003	4	71
21	IRS – P6	Solar Array SS Wing Solar Array ASS Wing LISS-4 Camera	17-10-2003	3	74
22	EDUSAT (GSAT - 3)	North Solar Array South Solar Array East Reflector West Reflector	20-09-2004	4	78
23	CARTOSAT - 1 (IRS - P5)	Solar Array SS Wing Solar Array ASS Wing	05-05-2005	2	80
24	INSAT – 4A	North Solar Array South Solar Array East Reflector West Reflector	22-12-2005	4	84
25	MTSAT - 2	Solar Sail/Boom	23-02-2006	1	85
26	CARTOSAT – 2	Solar Array SS Wing Solar Array ASS Wing Pin-puller Mechanism DGA Mechanism	10-01-2007	4	89
27	SRE - 1	Bio-mimetic experiment	22-01-2007	1	90
28	INSAT – 4B	North Solar Array South Solar Array East Reflector West Reflector	12-03-2007	4	94
29	INSAT - 4CR	North Solar Array South Solar Array East Reflector West Reflector	02-09-2007	4	98
30	CARTOSAT – 2A	*Solar Array SS Wing* *Solar Array ASS Wing* *Pin-puller Mechanism* *DGA Mechanism*	*28-04-2008*	*4*	*102*
31	*IMS-1*	*Solar array*	*28-04-2008*	*2*	*104*

SUMMARY

Solar array deployments	51	Antenna Pointing Mechanism	1
Reflector deployments	28	OCM Tilt mechanism	1
Solar Sail Boom	6	SOXS Mechanism	1
Solar Flaps	4	DGA Mechanism	1
Pan Camera/LISS4 Mechanism	3	Pin Puller	1
		Bio-Mimetic Experiment in SRE	1

Cartosat-2A --> Solar Array: 2, Pin puller: 1, DGA: 1

IMS-1 --> Solar Array : 2

6th National Seminar on Aerospace and Related Mechanisms

ARDE, PUNE, 28-29 March 2008

1. **Shri Vasant Gowariker, Former Director, VSSC, Shri Surendra Kumar, OS and Director ARDE and Shri AM Datar, Associate Director, ARDE, Sri MK Abdul majeed President INSARM and Dr. VK Saraswat, DS & Chief controller R&D (MSS)**
2. **Shri. MK Abdul Majeed, President INSARM addressing the seminar**

3. **Exclusive exhibition showcasing the developments of DRDO & ISRO**
4. **A Souvenir was released on this occasion**

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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