13.5.1. Development of nano-particle based polymer composites flexible material

One of the possible technique to protect the electronic component from Total ionisation is providing shielding. The conventional techniques employ usage of high density metals to attenuate the radiation. However, this causes mass penalty and also the secondary radiation which may have adverse effect on the semi-conductor. Nano-particle impregnated polymer material is one of the possible solution providing shielding with advantage of lower mass as well as flexible material which can be shaped as per the component package.

13.2. Research Areas in Material and Process Development

13.2.1. Development of Nano material based components for Space Applications

Satellite payloads require a large range of mechanical elements. Some are having structural requirements with critical CTE (brackets, spider etc) others require resilience to thermal excursions (feeds, Filters and cavities etc) or high thermal conductivity with zero CTE (for mounting of heat sinks / pipes for detectors and other high power devices) and many are serving as enclosures for electronics.

Nanomaterials such as CNT, Fullerenes, Graphene, Quantum Dots are used as reinforcement in composites such as metal matrix, ceramic matrix and polymer matrix to achieve required bulk properties.

Further, surface properties can be tailored using nano materials like Titanium dioxide, Gold & Silver nano particles, Zinc oxide as surface treatment for future aerospace components.

Scope:

- Theoretical study, optimization and testing of nanomaterial reinforced composite structures for space applications.
- Demonstration of these material for typical payload structures in terms of customisation of desired properties coupled with miniaturization.

Anticipated Benefits:

Mass reduction combined with high thermal & electrical conductivity low CTE culminating into a miniaturised functional product.

13.2.4. Development of new smart materials for space applications

Smart materials possess adaptive capabilities to external stimuli, such as loads, force or environment, with inherent intelligence. Smart materials which possess the ability to change their physical properties in a specific manner in response to specific stimulus input. The stimuli could be pressure, temperature, electric and magnetic fields, chemicals, hydrostatic pressure or nuclear radiation. The associated changeable physical properties could be shape, stiffness, viscosity or damping. Smartness describes self-adaptability, self-sensing, memory and multiple functionalities of the materials or structures.

Probable Applications:

Spacecraft & Antenna deployment, shape control, flexible structure vibration control, jitter isolation, precision pointing, etc.

Smart materials, regardless of technology field, can be broken down into the following categories:

- Sensing
  - System Identification
  - Health Monitoring
- Quasi Static
  - Deployment
  - Positioning
  - Shape Correction
- Vibration Control
  - Structural
  - Acoustic

Scope:

- Development of new material processes
- Testing & qualification methodology

Anticipated Benefits:

Smart Materials finds applications in harsh environments of space and where on-board actuations are necessitated.

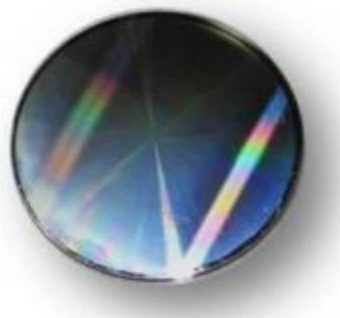
11.2.4. Development of Reflective Optical Coating over PMMA Resist

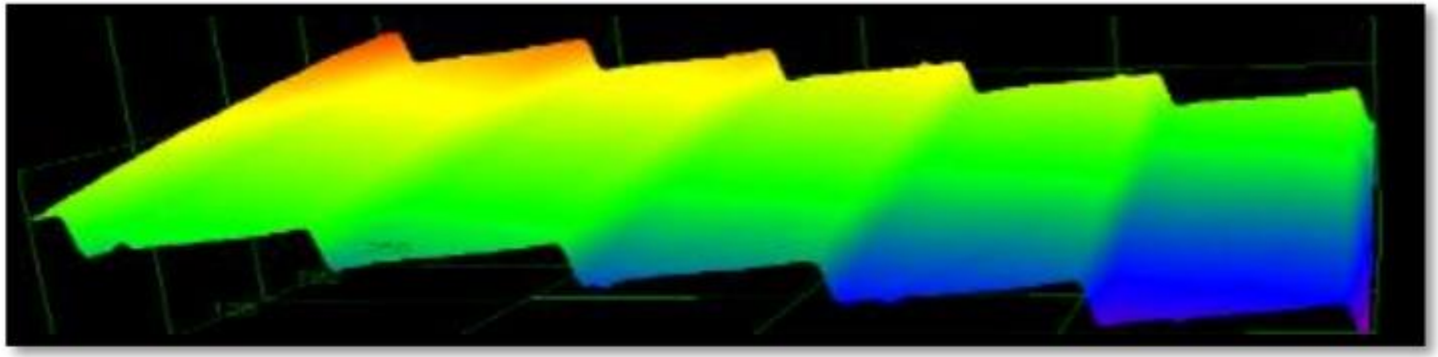
Optical coating is an important process in several micro/diffractive optical devices in order to alter the way light interacts with them. To achieve required reflectance in the desired wavelength range appropriate reflective optical coatings are used. This application requires reflective optical coating on 2D/3D shapes fabricated over Poly Methyl Methacrylate (PMMA), a polymer.

This work requires the development of optical coating over 950K PMMA Electron Beam Sensitive Resist. The structure shall have either binary or greyscale resist pattern over planar or non- planar substrates of irregular sizes. The coating shall have excellent adhesion with resist (PMMA) and shall preferably be abrasion free.

The activity shall include the following:

a. Survey and selection of required materials as per detailed SAC requirements.
b. Development of optical coating process over Patterned PMMA Resist Structures.
c. Process, coating performance demonstration and qualification.





Blazed grating on Silicon plano-convex lens

13.1.6. Study & Evaluation of Coefficient of friction between different types of materials, interfaces & surface conditions.

Evaluation of Coefficient of friction between different material is of prime importance in space industry to determine the slippage margin, possibility of screw loosening during dynamic vibration testing. Incorrect coefficient of friction increases uncertainties, which can lead to failures during testing, it can be avoided, if accurate values are taken at the time of design and structural analysis.

Scope:

- Literature survey of International standards and compilation of standard coefficient of friction between the material interfaces encountered in space hardware and method of determination of coefficient of friction.
- Creating an indigenous database of coefficient of friction values for various material interfaces for usage at the time of design.

Anticipated Benefits:

Study and tabulation of Coefficient of friction values will decrease failures/anomalies observed post dynamic testing and improve the design review process.