

# MATERIALS FOR ROCKETS AND MISSILES

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# I. Selection of Materials

- High Specific Strength.
- High Specific Modulus.
- Fabrication Easiness.
- Easy availability.
- Critical requirements.
- Service Conditions.

## II. Special Requirements Under Adverse Conditions

- ▣ High Pressure.
- ▣ High Temperature.
- ▣ Thermo-Structural needs.
- ▣ Soft Magnets.
- ▣ HED Permanent Magnets.
- ▣ Bi-metallics.
- ▣ Opto-Electronics.
- ▣ Electro-Optics.

# TYPES OF MATERIALS

- ▣ 1. Structural Metallic Materials.
- ▣ 2. Composite Materials.
- ▣ 3. Thermo-Structural Materials.
- ▣ 4. Thermal Protection Materials.
- ▣ 5. Special Materials.
- ▣ 6. Chemicals.

# 1. Structural Metallics.

- ▣ i) 15 CDV6 : Low carbon steel used in solid rocket motor case.
- ▣ ii) M250 : Maraging steel with high strength and high toughness used in booster solid rocket motor case.
- ▣ iii) Titanium alloy: (Ti-6Al-4V) used in high pressure gas bottles .

iv) Aluminium Alloys: used in liquid propellant tanks, engine components, airframe in Reusable Launch Vehicles.

Types: AA 2219, AA2014, AA6061.

- . v) Magnesium/ Mg-Lithium alloys: used in upper stage structure like payload adopter, avionic decks, equipment bay structure.
- . vi) Powder metallurgy products: used in nozzle throat for bi-propellant control thrusters.

## 2. Composites

- ▣ i) Carbon F / Kevlar F – Epoxy Resin : used in solid motor case, pressure vessel, interstages, payload adopter.
- ▣ ii) Carbon C / Silica C – Phenolic Resin : used in ablative liners, nozzle throat inserts.

# 3. Thermo- Structural

- ▣ i) Carbon Fibre/ Silicon Carbide Ceramic Matrix

Used in nose-cap of heat-shield, leading edge and control surface of RLV.

- . ii) SiC F/SiC Ceramic Matrix Composite: used in high temperature / hot structures.

# 4. Thermal Protection System

- ▣ i) Carbon/Carbon Composite: used in nozzle throat, nosecone ( SiC Coating).
- ii) Silica tiles: (Silica Fibre in Si gel ) used in space shuttle and SRE (capsule )mission.
- iii) Polyurethane foam insulation for cryogenic propellant tanks and subsystems.
- iv) Flexible Reusable Surface Insulation-FRSI Blanket / felt with Teflon coating used in leeward surface of RLV.

# 5.Special Materials

- ▣ i) Soft magnetic alloy: Fe-Co-V : used in torque motor in spacecraft.
- ▣ ii) HED permanent magnet: Sm-Co : used in gyroscope, inertial navigation, guidance & control system, reaction momentum wheel in spacecraft.
- ▣ iii) Bimetallics: (SS-Al and SS-Ti)used in Cryosystem for assembly of dissimilar items.

- ▣ iv) Opto-electronics: used in photo sensors and photo diodes and photo voltaic devices for power generation in satellites.
- ▣ v) Electro-optics: used in High resolution imaging in Spacecrafts.

# 6. Chemicals

- ▣ i) Different coating materials are used for protection and imparting certain characteristics to surfaces, potting of connectors.
- ▣ ii) Variety of adhesives/ bonding agents are used in processing, installation of sensors, assembly and integration operations.
- ▣ iii) Most of these chemicals are polymers.