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# Missile Materials

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# Missile Materials: Current Status and Challenges

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***Abstract*— The development of missile materials is the key to indigenous materials and their components. The selection of materials includes some the properties such as high strength to weight ratio, easy fabrication, good corrosion resistance, reliable quality, and high fracture toughness. The materials used for the airframe and propulsion system are alloys of aluminum, titanium, magnesium, and maraging steel. Non-metallic materials are also used such as carbon-carbon composites and polymer materials. High purity materials like phosphorous, and silicon are also important for material advancements. The paper outlines the needs and challenges of research and its solutions.**

***Keywords- Missile materials, challenges, current status.***

## I. INTRODUCTION

The construction of the missile is based on available technology, as well as skill required to be touched from where it is located within the country[4,6]. A variety of selected items are selected, appropriate and used as completed products. This paper covers the main features of the current equipment, and describes some of them challenging areas.

## II. DESIGN AND QUALITY REQUIREMENTS

The materials used for the missile system have a specific design and quality requirements listed below:

• High strength to weight ratio (having the structure as simple as possible)
• Good resistance to corrosion (avoiding poor performance during storage)
• High fracture toughness
• Good fabrication qualities
• Detectability of defects
• Reliable quality.

## III. METALLIC MATERIALS

### A. Magnesium Alloys

As a consequence of their low density (resulting in low weight), magnesium alloys have been employed in the outer shells, wings, and control regions of aircraft.

The key areas for obtaining large magnesium alloy casting and plates are:

• Improvements in technology for simulation, molding, rolling and heat treatment.

• Develop a CNC machine strategy for the production of precise profile parts

• Development of decontamination treatments and vacuum insertion techniques to ensure end life.

Agencies such as HAL, DMRL, MIDHANI and other private sectors are involved in this with the DRDL also make these components completely indigenous.

### B. Alluminium Alloys

Aircraft airframes and propulsion systems make extensive use of a diverse array of aluminum alloy products, such as sheets, forgings wrapped in rings, extrusions, forgings, and castings. A1-Mn-Si Mg Alloys (65032A) were selected due to their superior corrosion resistance, fuel compatibility and oxidizer compatibility, good heat avoidance and management, and superior heat management. The following are examples of key technology developed and commercialized by Indian industries:

• BALCO is responsible for the manufacturing and certification of aerospace-grade alloys.

• Chemicals are used to reduce the thickness of the plate.

• Automatic TIG heating in a place free of dust and with humidity under control.

• Extinguish the fire with a delay of no more than 10 seconds after the water has settled. Four large enterprises in both the public and private sectors have now created and established the manufacturing of mobile tankages. Consequently, the number of self-assurance technology operating centers has increased significantly.

These subjects face the biggest intellectual obstacles:

• Enhancing high-strength alloys with the designation IS: 24345

• Enhancing the process of joining by employing modelling and delivering modelling courses

• Altering the chemical makeup of filler materials to produce durable, non-fracturing joints

• A reduction in the residual stress that, when the equipment undergoes further heat treatment, causes a magnitude distortion.

### C. Titanium Alloys

Titanium alloys, namely Ti-6A1-4V, are utilised for high-pressure airbottles and sustainer casings due to their better strength at half the density of steel. This enables the materials to withstand higher levels of pressure. They also have an excellent resistance to corrosion, which contributes to their widespread use. Titanium alloy hemispheres may be formed and welded using TIG and electron beam processes by subjecting the material to high temperatures, applying pressure, and utilising superplastic construction lines.

The critical areas of R and D are:

• Improvement of high strength filling and durability
• Technology for wrapping their sheets

• Distribution of titanium alloys.

### D. High Strength steels

The Maraging Instrument, also known as the MDN-250, is employed for the processing of rocket motor casings and firing chambers. This high strength steel is chosen because it exhibits a high breaking strength in addition to high strength and only a small deviation as a result of the lack of water quenching following the heat treatment. Manufacturing employs some of the most well-established and well-initiated technologies, including flow structure, controlled temperature control, moulding, and welding. These technologies are employed in a range of fields[1].

The current interest is to replace the expensive metal with more imported ingredients at the moment another Ni-Si-Cr-Co metal built into DMRL, as well as rust development resistance to atmospheric resistance. Significant efforts of R and D are required to improve (i) metal coating processes low risk of hydrogen embrittlement, (ii) strategies to strengthen the air of consistency extinguishing of heavy metals and (iii) corrosion-resistant metals in the ocean atmosphere.

### E. Other Metallic Materials

Gyroscopes are typically constructed from soft magnetic alloys, flexible controlled alloys, hard tungsten alloy spheres, nickel-based super alloys, copper beryllium, and high copper with oxygen-free conductivity.

R&D should concentrate on the following areas: • Production of small-scale alloys and their applicability

Traditional alloys with magnetic, electrical, and thermal properties may now be isolated from one another.

• Construction of molybdenum vessels is essential for the lowering of the metallurgical powder route for warhead spheres.

## IV. ELECTRONIC MATERIALS

The scientific community in India faces a wide range of challenges as a result of the proliferation of electronic materials. Even though many different organizations like BEL, ITI, ECIL, and SCI are creating components, the essential raw materials are frequently brought in from outside the country. Scientists, research facilities, and businesses operating in this industry should examine the current research and development requirements.

## V. NON METALLIC MATERIALS

### A. C-C Composites

Carbon-carbon compounds are better than most of the other materials used in aircraft in the following ways: It keeps its temperature and doesn't melt at temperatures as high as 3000 degrees Celsius. It has both a high thermal conductivity and a low thermal conductivity (leading to high resistance hot shock)

• Keeping mechanical strength and good collision structures over a range of temperatures

In the process of making C-C products, the following groups are involved:

• Carbon fiber is woven on the preform in three dimensions

• Pitch is soaked between 300 and 400 degrees Celsius

• Carbonization, which happens at 1000 °C

• Isostatic pressure at 850 degrees Celsius and 1000 kilograms per square centimeter

• The process of graphitization at 2750 °C

Here are some examples of thrust R&D projects in areas where C&C work together:

• A study of how heat moves through a solid domain in relation to its temperature

• Thermo-structural analysis using simulated situations

• Fitness test (flexible load vibration and ground resonance testing)

• Microstructural examination to find out how the fibres and matrix are spread out, as well as how the holes are spread out,

Damage analysis that takes both the isotropy and unitropy of the matrix formation into account

• The parameters of pitch impregnation and how to make congestion work even better.

### B. Polymeric Materials

Polymers can be used in arrows in the following ways: • As high-strength polymer bonds for composite, high-density propellants in the propulsion system

Hydrogen-to-carbon ratio, low molecular weight of exhaust, high temperatures and pressures during combustion, and specific pressure

• As line elements in heated chambers with high thermal stability, low thermal conductivity, and a high "char" value. They also have high durability values, but not so high that they can't be fixed. They have high-strength adhesive structures with steel/A1 and reinforced fibres like carbon, glass, and asbestos.

• As a heat-resistant polymer that can stop hot erosion in rooms. Alators are made of silicone phenolic resin, FRP, or thermosetting or thermoplastic materials.

• As polymeric coatings or paint on missile launchers to protect them from scratches, rust, and erosion in the sea air

• As an adhesive for steel bonds and carbon-FRP bonds, as well as a sealant for elastomeric metal composites.

• As ingredients that don't mix, which lowers the risk of fire, and as pipes made of elastomer rubber. pipes, diaphragm, sealants etc.

• Plastic parts are transparent to radar and light, and they are also transparent to electricity.

The problems in R&D areas are:

• Estimating how long polymers will last after being used

• In 3rd generation cell compounds, homogeneous synergistic compounds for large coil molecules that are dispersed, strong, and flexible.

## CONCLUSIONS

(I) Disposable items are chosen for their distinct characteristics, such as their high strength-to-weight ratio, resistance to breakage, high corrosion resistance, simplicity, and degree of dependability.

(II) In addition to metals such as magnesium alloys, aluminum, and titanium, and maraging steel, non-metallic materials such as polymers and carbon-carbon combinations are frequently used.

(III) The development and installation of electronic inland infrastructure is urgently needed.

(IV) Major focus areas include new technologies, laboratory manufacturing, and testing equipment measurement using the consortium technique. Furthermore, the establishment of effective prices and the use of reliable manufacturing technologies are major areas of concern. Educational institutions, research and development laboratories, and industry communications should all be established to solve the issues connected with the arrow system in Indian manufacturing.

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