Military materials

Challenges and opportunities

September 2020

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1. Introduction

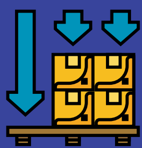
For domestic manufacturers, the opportunities in the defence manufacturing sector have grown over the last few years. Achieving indigenisation of some critical spares and platforms has been one of the main cogs in this growth. Although significant strides have been made towards achieving self-reliance in spares and platforms manufacturing, India still has a large import bill of raw materials. The disruption of supply chains across global territories due to the COVID-19 pandemic has further emphasised the need for self-reliance, especially in strategic sectors and indigenous development and manufacturing of materials (including special alloys), to be taken up urgently.

This report highlights the availability and applications of strategic military materials. It explores the demand and trade situation whilst analysing the strategic importance along with the current challenges of manufacturers in indigenously producing these raw materials. The paper also highlights the policy interventions adopted by various countries globally to secure the supply chain of these critical resources.

2 Overview

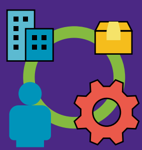
‘Military materials’ are critical metallic and non-metallic raw materials used for defence manufacturing. India has a significant import dependency for strategic military materials and is majorly dependent on China, Democratic Republic of Congo (DRC), Russia, Brazil, Australia and U.S.[1] Although there have been a few success stories in substituting imported material with indigenously produced materials, defence manufacturers still heavily rely on imports to fulfil their requirements. The high dependence on imports puts a constraint on the ability of Indian organisations to export defence equipment/ platforms thereby limiting the growth of the country’s defence industrial ecosystem.

2.1. Strategic importance



2.1.1. Import substitution

As per recent estimates, India imports approximately INR14000 crore (USD2 billion)[2] worth of critical materials annually. Domestic production of these materials can reduce the import bill as well as decouple strategic military assets from geo-political uncertainties.



2.1.2. Securing the supply chain

In the event of a global disruption such as COVID-19, procurement and supply of military materials across the globe has been affected. During these times, the preparedness of the military is even more critical, which can be facilitated with the setting up of local manufacturing. Countries globally are cognisant of these factors and are formulating policies to ease domestic production and secure supply chain.

2.1.3. Self-sufficiency in defence

Self-sufficiency in high-end military materials is critical with the Government of India (GoI) raising concerns and pushing for an indigenisation policy.

2.2. Major material groups in aerospace and defence

The prime metallic/non-metallic material groups used in aerospace and defence manufacturing include steel, aluminium, titanium, copper, cupronickel, tungsten, composites and ceramics. These materials are used in combination with other metals such as nickel, vanadium, zinc, cobalt antimony, molybdenum, borates, chromium, germanium and lithium to form specialised alloys. These alloys then undergo special treatments such as forging and casting to make them lighter, stronger and blast resistant and are then machined into desired shapes and sizes.

2.2.1. Aluminium

Aluminium is mainly known for its light-weight properties and the material strength is doubled when it is processed in cold conditions. Further, alloying aluminium with elements such as iron, silicon, copper, magnesium, manganese and zinc in different combinations increases its strength.

2.2.2. Steel

Steel is up to four times stronger and three times stiffer than aluminium. Maraging steel grades are carbon-free iron and nickel alloys with additions of cobalt, molybdenum, titanium and aluminium, which give it high strength. Further, alloy steel grades bring high strength and yield with heat treatment capabilities, such as hardening, nitriding and case hardening. Stainless steel grades provide corrosion resistance with some grades suitable for heat treatment.

2.2.3. Titanium

Titanium is 30 per cent stronger than steel but is nearly 50 per cent lighter and it is 60 per cent heavier than aluminium, but twice as strong. Titanium is alloyed with aluminium, manganese, iron, molybdenum and other metals to increase strength, withstand high temperatures and lighten the resultant alloy.

2.2.4. Tungsten

Tungsten heavy alloys (WHA) are promising materials for a wide range of applications, such as radiation shields, kinetic energy penetrators, and counterbalance weights, in the medical, military and aerospace sectors due to their superior properties of high strength, density, radiation absorption and good wear resistance. In WHA, nickel, iron, copper and cobalt are commonly added to a tungsten matrix that serves as a binder and provides ductility to the materials.

2.2.5. Composites

Composites offer high strength, durability and stiffness whilst being light-weight, resistant to corrosion, simple to repair and offering the freedom to design complex structures. The fibres used in composites are mainly carbon, glass and aramid while the resin matrix can be epoxy, phenolic, polyester, thermoplastic, etc.

2.2.6. Ceramics

High-performance ceramics have been key for delivering multiple benefits in challenging and hostile environments. Unique characteristics, such as light weight, high hardness, corrosion resistance and high melting points, have made ceramics the materials of choice in nuclear, aerospace, defence and industrial applications, among others.

The following table summarises the grades and typical application areas of these different material groups.

Grades of different military materials and their applications		
Material	**Applications in aerospace and defence**	**Major grades and types[3]**
Aluminium alloys	Fuselage body and bulkheads, wing skins, engine components and fittings	2000, 5000, 6000, 7000, 8000 series
Special steel alloys	Cabin components, landing gears, aircraft fittings, fasteners, actuators, jet engine shafts, structural tubing, ballistic tolerant components, motor and fixing components	15CDV6, 17-4PH, 17-7PH AISI 4130, 4140, 4330, 4340, 4620, 6150, 8640, HP-9-4-20 Maraging steel (200, 250, 300, 350)
Titanium alloys	Aircraft structural items, panels, fastening systems, fan and compressor blades in aviation; tank armours in army; rigging equipment, shipboard cooling systems, submarine ball valves and heat exchangers in navy	Ti-6Al-4V (UNS R56400), Ti-6AL-4V ELI, 6AL-6V-2Sn-Ti, Grade 5
Tungsten alloys	Armour plates, high-speed armour piercing ordnance; high thermal strength machine parts, rotor/propeller blades and anti-vibration weights, flight control surface components such as rudders, elevators and ailerons	AMS-T-21014, AMS 7725
Super alloys	Fuel nozzles, washers, bearing races, spacer sleeves, flare castings, engine vanes, bearing supports and other structural parts	Nickel based (UNS N06600, N06617, N07750), cobalt based (UNS R30605, R30035, R30783), iron based (UNS N08800, N08825, S66286)
Ceramics	Engine and exhaust components, thermal protection shields, structures for ultra-high-speed flying objects, lightweight turbine components that require less cooling air such as vanes, nozzles, seals and valves	Alumina, carbides (boron and silicon), Ceramic Matrix Composites (CMCs)
Composites	Wing skins, forward fuselage, flaperons, rudder, rear pressure bulkhead, keel beam, front fairing, upper fuselage shells, crown and side panels and structural elements of modern helicopters	Carbon fibre, glass fibre, aramid fibre
Copper and Cupronickel alloys	Aircraft landing gear components, bushings and bearings	AMS 4596-C72900; AMS 4597-C72900; AMS 4598-C72900, AMS 4640-C63000, AMS 4590-C63020

2.3. Specifications and standards

The specification, composition and method of production, as well as physical and chemical properties of any raw material in any equipment is provided by the designer of the equipment in its technical datasheet based on design parameters. These datasheets often draw from standardised material specifications which are created by various trade and professional organisations, such as the SAE International (previously Society of Automotive Engineers), ASTM International (previously American Society for Testing and Materials), CEN (European Committee for Standardisation), British Standards Institution, Deutsches Institut für Normung (DIN) standards and the International Organisation for Standardisation. Some of the commonly used global standards are the Aerospace Standards (AS), Aerospace Material Specifications (AMS) and Ground Vehicle Standards (J-Reports). Thus, the standards and specification used for a platform will depend on the country of origin of that platform and the standards applicable in that country or region.

In India, the Department of Standardisation (DoS) is responsible for conducting standardisation activities for equipment. DoS operates under the control of Department of Defence Production (DDP), Ministry of Defence (MoD). The broad policies of DoS is formulated by the standardisation committee. The DoS interacts with various organisations and agencies within and outside the MoD such as the Indian Army, Indian Navy, Indian Air force, Director General of Aeronautical Quality Assurance, Director General Quality Assurance (DGQA), Defence Research and Development Organisation (DRDO), Ordnance Factory Board (OFB), Defence Public Sector Undertakings (DPSUs) and the Bureau of Indian Standards (BIS). The DoS prepares five types of standardisation documents in respect of components, assemblies, sub-assemblies, equipment and other defence stores:

- Joint Services Specification (JSS)
- Joint Services Preferred Range (JSPR)
- Joint Services Rationalised List (JSRL)
- Joint Service Guide (JSG)
- Approved Notification (AN) for adoption of Indian standards.

There is a dedicated Material Standardisation Sub-Committee (MSSC) that deals with the standardisation of specifications of materials for defence applications. Apart from laying the standards for materials, they are also responsible for harmonisation between the international and Indian standards. The DoS has signed an agreement with the Allied Committee 135 (AC/135), the apex body of NATO Codification System (NCS), for India to become a member of AC/135. This agreement has placed the Indian codification system at the international level and the Indian Navy uses the naval standards for design and manufacture of naval surface and subsurface vessels.

2.4. Quality assurance and certification

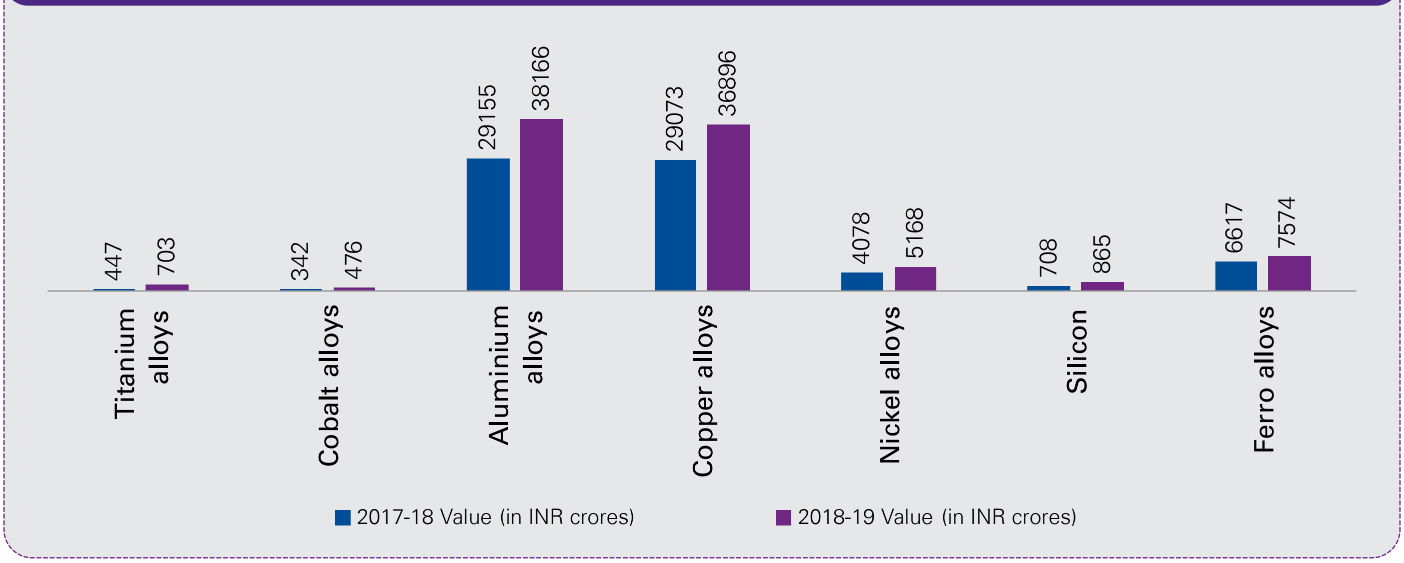
For manufacturers to qualify as raw material suppliers for aerospace and defence application, having a robust Quality Management System (QMS) in conformity with the stringent requirement of the sector is essential. Certifications, such as AS 9100, ISO 9001 and ISO/IEC 17025 are some of the essential certifications required. In addition to these certifications, suppliers need their QMS audited and approved by the original equipment manufacturer (OEM) to become an approved source of raw material. In India, additional approvals from the Director General of Aeronautical Quality Assurance (DGAQA), Director General of Civil Aviation (DGCA), Director General of Quality Assurance (DGQA), Department of Space (DoS), etc. might be required based on end-use of the raw material to qualify as an approved supplier. Change in specification of material generally requires recertification of the entire platform, especially for airborne systems.

3 Opportunities and challenges

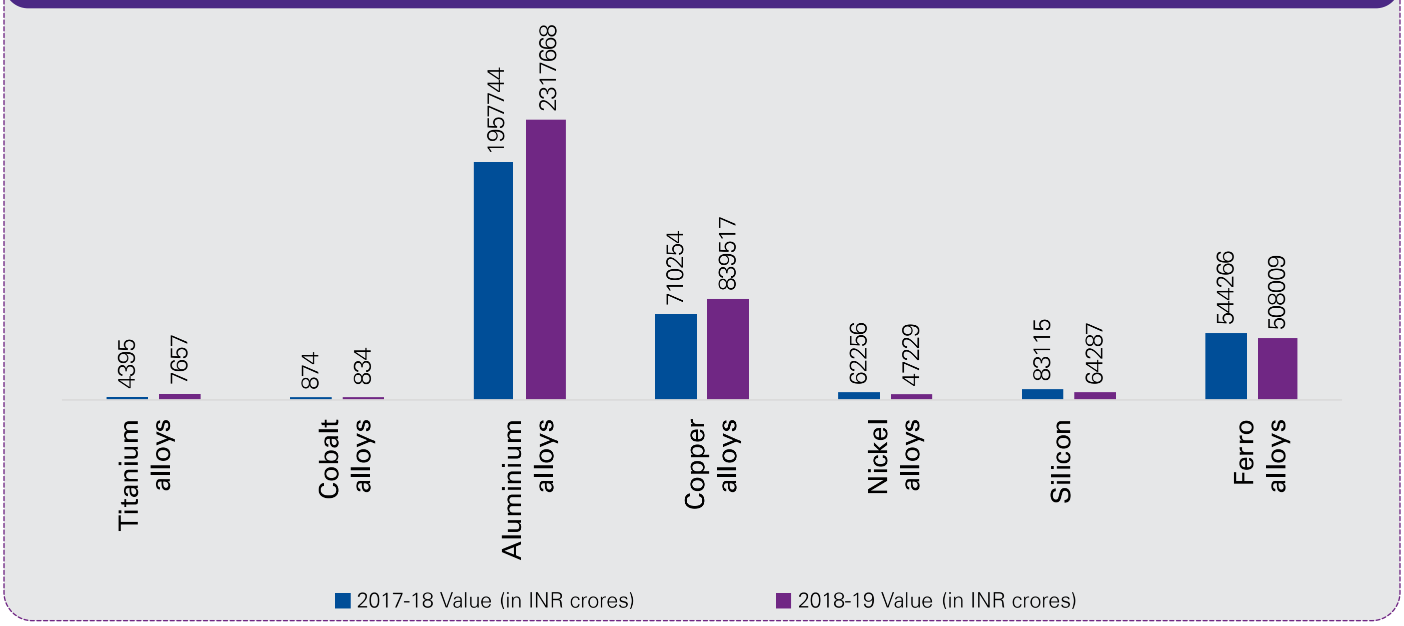
India being mineral-rich, makes it a leading supplier of minerals and ores for most of the strategic material groups. For example, India is the fifth largest supplier of ilmenite, a black iron-titanium ore and has 18 per cent of the total global reserve. Similarly, India is the fourth largest supplier of bauxite, the aluminium ore, with 13 per cent share of global bauxite production and the fourth largest supplier of iron ore with annual production of more than 200 million tonnes.[4]

Despite this, India's imports of key metals and alloys are increasing. This is evident from the below charts.[5]

Change in value of imports from 2017-18 to 2018-19



Change in volume of imports from 2017-18 to 2018-19



Further, Indian defence manufacturers, majorly comprising DPSUs and DRDO labs, import a significant quantum of their raw material requirements. For example, HAL, which is the largest DPSU, imported INR3629.4 crore (USD500 million) worth of raw materials in financial year 2018-19.[6] Indian defence manufacturers imported high-end alloy steel to the tune of INR5250 crore (USD700 million) in financial year 2018-19.[7]

In non-metallic materials, India has developed capabilities in composite components based on glass, carbon and aramid fibres, but apart from glass fibre, the manufacturing capabilities for aramid fibres such as Kevlar and aerospace grade carbon fibre are absent.

The materials used in indigenous platforms also have high dependency on imports, such as Light Combat Aircraft (LCA) Tejas Mk 1A, which has 45 per cent of its airframe based on carbon composites.[8] Carbon composite airframes are also expected to be extensively utilised in the development of Light Combat Helicopters (LCH), Advanced Light Helicopter (ALH) Dhruv, Medium Weight Fighter (MWF) Tejas MK 2 and the fifth generation Advanced Medium Combat Aircraft (AMCA).

3.1. Domestic market

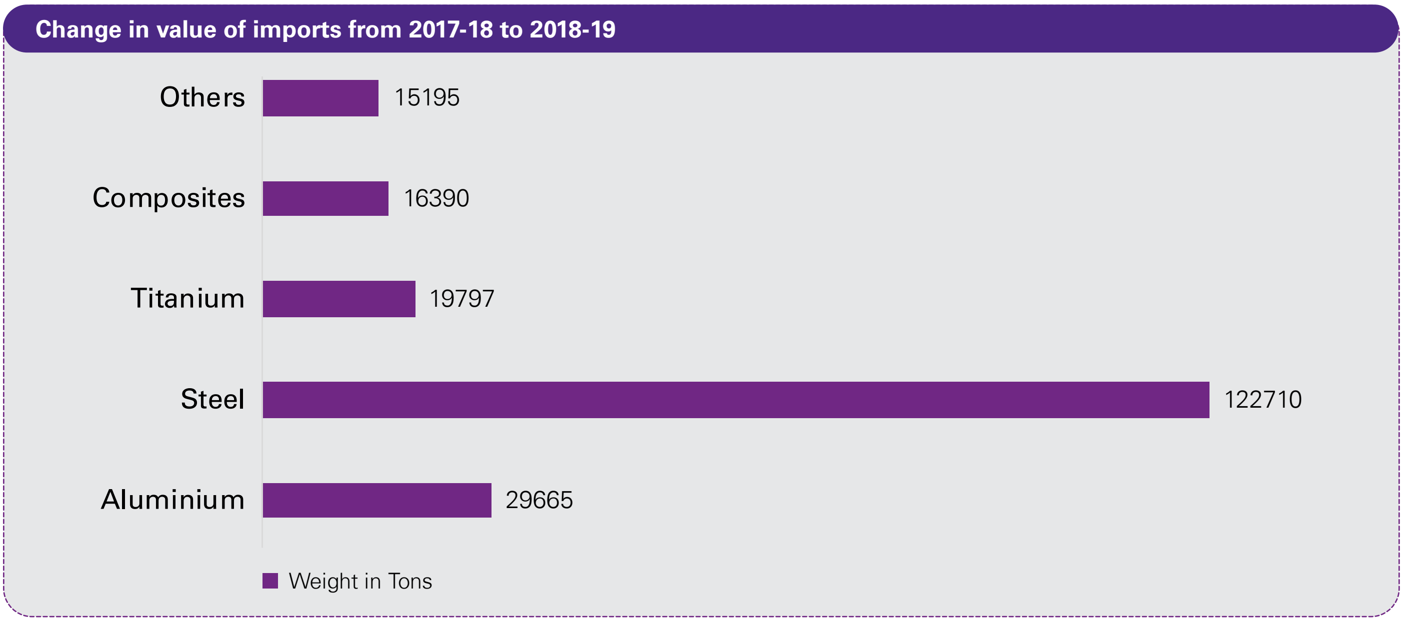
The push towards indigenisation, as well as the modernisation plans for the Indian armed forces, are the key drivers of the domestic market. As per the defence modernisation plans and the TPCR 2018[9] document, India plans to induct several platforms and systems and it is expected that many of these platforms and components will be manufactured in India. Some of the key platforms along with the quantity to be inducted are as follows.

Platform	Platform Type	Total Requirements
Twin Engine Aircraft (AMCA)	Air	150
Single Engine Aircraft (MWF + Tejas)	Air	314
Helicopters	Air	300
UAVs	Air	350
Missiles	Air	6850
Frigate/ Destroyer/ Corvette	Naval	30
Submarines	Naval	6
Auxiliary Ships	Naval	70
Patrol Boats	Naval	35
Main Battle Tanks	Land	120
Infantry Combat Vehicles	Land	2160
Artillery	Land	1500
Small Arms	Land	6,70,000
Special Vehicles	Land	3250
Small arms Ammunitions	Land	1,50,00,000 annually

The material requirement for these platforms can be classified into direct materials and indirect materials. Direct materials are those that are utilised to manufacture the core platform and structural elements. The indirect materials are those that are used to create systems and subsystems such as engines, electronics and avionics and weapons systems that get fitted into the core platform. Based on the direct material usage in comparable platforms that are in service globally, the approximate breakup of the quantum of different materials utilised to manufacture one unit of the above listed platforms are as follows.[10]

	Direct structural materials (kg)				
Platform	Aluminium	Steel	Titanium	Composites	Others
Twin engine aircraft (AMCA)	2350	800	1200	2300	1170
Single engine aircraft (MWF + Tejas)	2240	280	280	2240	560
Helicopters	945	315	470	945	473
UAVs	80	25	0	640	60
Missiles	260	200	160	200	200
Frigate/ Destroyer/ Corvettes	122500	1400000	0	87500	140000
Submarines	77000	639100	0	23100	30800
Auxiliary ships	35000	400000	0	25000	40000
Patrol boats	40500	162000	0	40500	27000
Main Battle Tanks (MBT)	5000	12500	3750	2500	1250
Infantry Combat Vehicles (ICVs)	4900	8800	2900	1900	1000
Artillery	0	3600	0	0	400
Small arms	0	3.5	0	0	0.5
Special vehicles	2250	4050	1350	900	450
Small arms and ammunitions	0	0	0.05	0	0

Thus, the consolidated total volumes of different materials that will be directly utilised for manufacturing the listed platforms are shown in the chart below.[11]



It should be noted that the above projection is only for the direct material requirement of the platforms under consideration. The total demand is expected to be much higher if an exhaustive list of platforms and systems is analysed in addition to the material requirement that goes indirectly as part of armaments and systems.

On the supply side, manufacturing facilities of the some of the key grades of materials available in India are as follows.

Material type	Grades and types
Aluminium	2xxx, 6xxx and 7xxx series of speciality alloys.[12]
Titanium	Titanium sponge, Alpha and near alpha alloys, alpha-beta titanium alloy and Grade 1 (Aerospace grade titanium)[13]
Special steel grades	MDN 11-10 PH, 15-5PH, MDN 174, 15CDV6, 17-4 PH and maraging steel.[14]
Superalloys	Nickel, Cobalt and Iron based superalloys[15]
Composites	Glass fibre and resins.

*List is not exhaustive

There have been success stories in the import substitution of materials in platforms of eastern origin, e.g. DMRL had developed DMR 249 grade of ship building steel as an alternative to steel imported from Russia. The technology was transferred to SAIL and Essar Steel and currently almost the entire requirement for this grade of steel for shipyards is fulfilled domestically. Other example are armour plates and barrels of tanks namely T-72 and T-90, which have been successfully indigenised.

3.2. Key challenges in India

3.2.1. Minimum order quantities

Military materials are used for a variety of applications; however, a single order quantity for any specific grade of material is relatively small. These order quantities are generally below the minimum order quantity (MoQ) required to run a sustainable business. With little or low dual-use potential for some of these specific grades of material, the order volumes remain below sustainable levels. Thus, in comparison to commercial application, companies are not able to recover the investment associated with developing indigenous capabilities for these important materials.

3.2.2. Technology gap

The research and development required to develop specific grades of alloys and non-metallic material are cost-prohibitive and hence companies are reluctant to invest in R&D for these materials. Instead, industry often looks to license the technology, which have end-use restrictions and thus cannot be accessed without government interventions. The government recently has transferred technology from Defence Public Sector Undertakings and Defence Research and Development Organisation (DRDO) labs, including Defence Metallurgical Research Laboratory (DMRL), to bridge the gap. E.g., DMRL has transferred technology for high-nitrogen steel for armour applications and copper titanium alloy for non-sparkling tools.[16]

3.2.3. Multiplicity of technical specifications

The technical specification of materials for any defence platform is given by the designing agency of that platform. Hence, material specifications of platforms from foreign origins are designed as per standards, specifications and material availability in the specific country of origin.

After acquisition of such a platform, during transfer of technology from foreign OEMs, these design standards are continued not modified based on the standards and specifications prevalent in India because changing the design standards generally requires recertification of the entire platform. Indian forces use varies platforms from significantly varied countries thus resulting in multiplicity in the standards used for different platforms. Due to this multiplicity of prevalent specifications and need for recertification of the platform in case of change in design standards, Indian material manufacturers following Indian standards cannot substitute the imported raw material even if both materials are similar in terms of physical and chemical properties thereby creating a perpetual dependency on imported raw material.

3.2.4. Lack of testing facilities

India needs to enhance the testing facility infrastructure that is required for developing exotic materials. Lack of testing infrastructure increases the cost of research and hampers the development of new materials keeping the country dependent on imported materials.

3.2.5. Approved source certification

Another major challenge for the suppliers of military materials and alloys is getting certified as approved sources. Most global OEMs have a list of approved suppliers with long-term contracts for any given program. These suppliers get associated with the OEM from the development stages and become an essential part of the supply chain. The cost for switching suppliers for an OEM at a later stage is generally high and thus OEMs avoid changing suppliers, unless necessary. As a result, it is challenging for a company to get a sourcing certification for multiple vendors to generate volumes and bring down the unit cost.

3.3. Policy interventions

Governments around the world have dealt with issues pertaining to military materials in a variety of ways. We also look at the different measures taken and planned by the GoI to address the challenges mentioned previously.

3.3.1. Global practices

European Union

The European Defence Standards Information System (EDSIS) and the European Defence Standards Reference System (EDSTAR) were established by the European Defence Agency (EDA) to support the objective of a harmonised standardisation for defence procurement.[17] These systems and portals have been devised to ensure standardisation in the specifications of raw materials and components to be procured for defence applications. Similarly, the Acquisition Streamlining and Standardisation Information System (ASSIST) database system assists the U.S. Department of Defence (DoD) to define and enlist the standardised specifications for acquisition. These practices enable standards to be developed, recognised and used to optimise effectiveness and interoperability.

United States of America

The U.S. is the largest manufacturer of defence equipment and platforms, sourcing a large chunk of its strategic materials from across the globe. The work conducted by over 300 members of the Department of Defence (DoD)-led interagency task force identifies the factors and the efforts taken by the government to secure its defence industrial supply chain. Some of the current efforts undertaken are as follows.[18]

- Creation of a national advanced manufacturing strategy by the office of Science and Technology Policy focused on opportunities in advanced manufacturing.
- Establishing a process for enhancing the ability to analyse, assess and monitor vulnerabilities of the industrial base.

In order to safeguard their interests, the DoD recommended an action plan and the salient points of the recommendation were to:

- expand direct investment in the lower tier of the industrial base to address critical bottlenecks, support fragile suppliers and mitigate single points-of-failure;
- diversify from complete dependency on sources of supply in politically unstable countries.

3.3.2. India

The GoI has also undertaken several policy level interventions, while others are in the pipeline with government bodies and stakeholders. Most significant among these is the latest draft on DAP 2020, which lays special emphasis on domestic sourcing of military materials. DAP 2020 is an attempt to tackle some of the key challenges that were mentioned in the previous section. The main provisions in terms of military materials are as follows.

- For ongoing projects other than at 'Buy-Global', material composition to be examined by Service Headquarters (SHQ) at the RFI stage to check for feasibility of using indigenous materials.
- In case of the 'Buy and Make' category, exploration of Transfer of Technology (ToT) should be done if the material is not being manufactured domestically.
- For future requirements, DPSU/PSU platform manufacturers, R&D establishments and SHQ are to carry out environmental scans for identifying various materials that can be developed in the country through the following avenues.
  - Phased development of materials by platform manufacturers and R&D establishments through own resources or Indian industry.
  - Inclusion of ToT for manufactures and validation of materials in licensed manufacture projects by production agencies (PAs).
  - Seeking and prioritising/promoting ToTs for military materials against offsets through Indian industry.
  - Taking up 'Make' or Technology Development Fund (TDF) projects for development of materials.

DAP 2020 also lays down a detailed process and incentives for platform manufacturers to include indigenously manufactured materials during the procurement process.

MoD to obtain information of material requirement and their availability, from all relevant stakeholders like various platform and material manufacturers

Creation of a material manufacturing database

Database of all existing manufacturing capabilities in materials providing a suitable platform for periodic interaction between all stakeholders

Feasibility examination by the SHQ during RFI

Check for Substantial main material component in the platform/equipments/projects

Issuance of additional RFI to material manufacturers

Issued in addition/concurrent to the existing RFI for understand the requirements and needs of the material manufacturers

Identification of the material

Availability in India

Sourcing plan of the vendor

Cost of the material

Issuance of additional RFI to material manufacturers

Based on the above study, SHQ, at the time of seeking Acceptance of Necessity (AoN), may include the given methodology for sourcing the material.

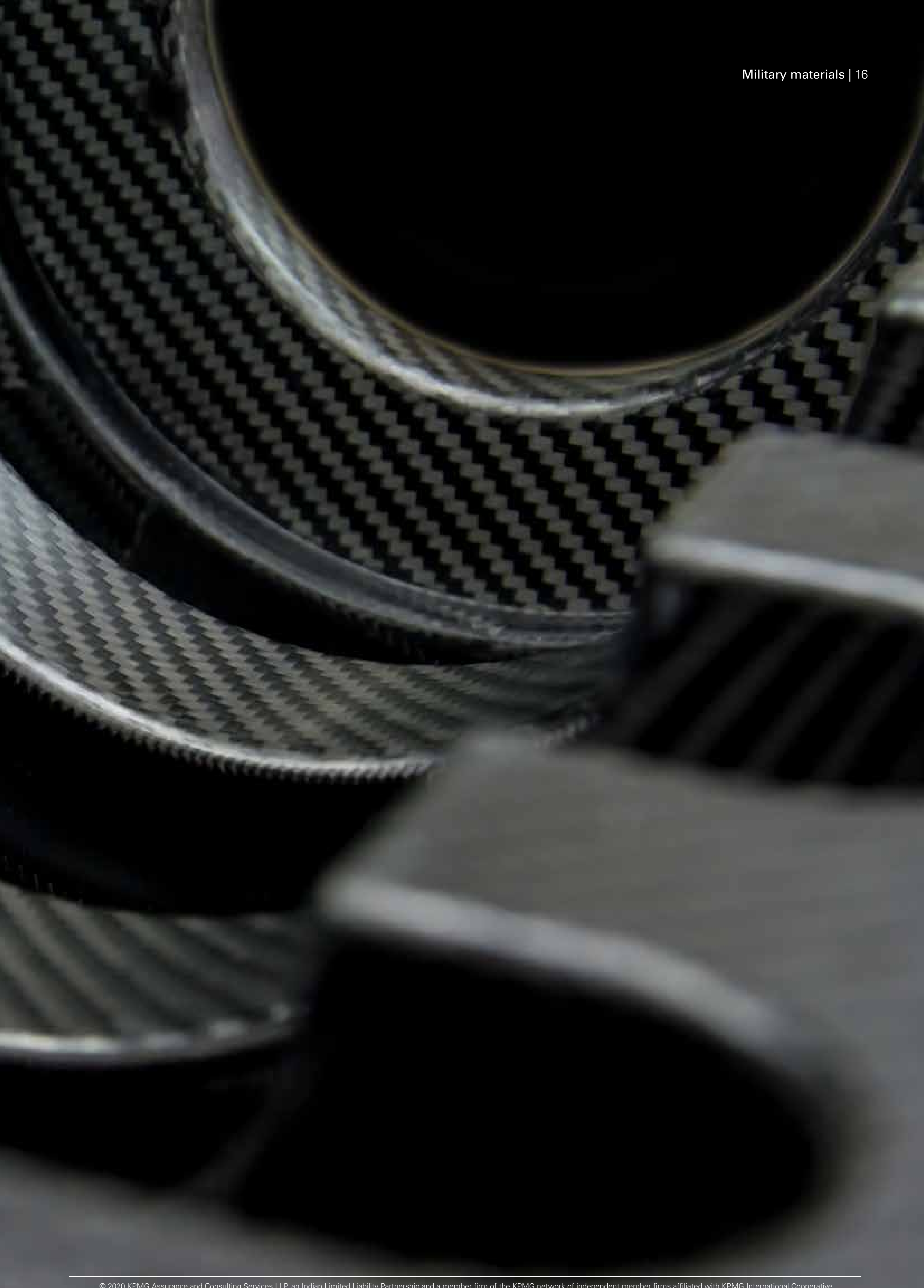
The methodology to incentivise OEMs to source indigenous material is as follows.

Reason for not using indigenous raw material	Suggested methodology under draft DAP 2020
Material(s) available in India but not being utilised for military applications due to lack of knowledge of availability of material(s) in India and/ or for convenience of use of material(s) from an established import source	Define the requirement of use of only indigenous material(s) and/or provide rewards subject to a cap of 0.5 per cent of total order value. In case of more than one material being used, the reward for each material should be in proportion to relative value and/or indicate likely sources as BNE material.
Not being utilised for military applications due to cost of indigenous material(s) being marginally higher compared to imports	Define the requirement of using only indigenous material(s) and/or provide rewards up to 15 per cent of the cost of the material subject to a maximum ceiling of 0.75 per cent of the total order value. In case of more than one material being used, the reward for each material should be in proportion to its relative value.
Not being utilised as the indigenous material(s) is not validated	Provide rewards up to 25 per cent of the cost of the material subject to a maximum ceiling of 1 per cent of the total order value. In case of more than one material being used, the reward for each material should be in proportion to the relative value. Based on the number of materials identified and the value addition to the manufacturing ecosystem, additional rewards may be granted by the DAC on a case to case basis. However, in all cases the cap for reward would remain at 1 per cent of the total project cost.

The policy will have multi-pronged impacts in dealing with the challenges faced by material manufacturers. Firstly, the process will bring transparency and reduce information asymmetry in available capabilities in the market thereby providing global exposure to various material manufacturers in India. Promoting local purchase of materials will assist in building order volumes to mitigate the business risks associated in setting up of a material manufacturing facility. Secondly, incentivising OEMs to locally procure materials will result in closing any technology gaps and, most importantly, incentivises OEMs to validate Indian material manufacturers as certified suppliers for their platforms. Indian manufacturers can then leverage such certification to expand their footprint globally. The policy also provides for higher offset multiples for transfer of technology to bridge the technological gap.

Some of the other key interventions and their possible impact have been listed here.

	Challenge	Policy intervention	Impact
Already approved	**Lack of economic order quantities**	Minimum procurement from SMEs has to be 25 per cent for all procurement by central PSUs.	The resulting growth of composites, precision manufacturing, forging and sheet metal would be a driving factor in creating demand for raw materials.
Already approved	**Technology transfer**	Transfer of technology by licensing from DMRL, MIDHANI, etc. for various military and dual-use applications.	Reduce the cost and time taken to develop a material grade in-house.
Already approved	**Lack of economic order quantities**	Increasing indigenisation requirements and import negative list.	Increasing indigenisation requirement will encourage OEMs to include raw materials in their procurement plan.
Under Planning	**Lack of economic order quantities**	Creation of an indigenisation portal to list the items (alloy and special materials) to be developed across services.	Will create better visibility on available markets to target thus assisting in driving up volumes.
Under Planning	**Lack of testing facilities**	Proposal for setting up defence testing infrastructure across the country under the Defence Testing Infrastructure Scheme (DTIS).	The proposed defence testing infrastructure will provide easy access to testing and certification of materials developed in house.
Under Planning	**Minimum order quantities**	The draft Defence Production and Export Promotion Policy (DPEPP) provides for assurance of long-term orders.	Long-term orders will give manufacturers surety of revenue to sustain the development of new materials.



4. Way forward

With the changing policy landscape, significant opportunities are expected to open up for material manufacturers. However, till the volumes and value of the materials are commercially viable propositions, manufacturers are likely to stay away from investing in dedicated facilities towards production of these special grades of material.

4.1. Long-term strategic material policy

The need of the hour is for government and manufacturers to work in close association with each other on a long-term concerted effort towards developing domestic capabilities. A think tank or nodal agency should be constituted wherein synergies of various incentives given by different ministries can be consolidated into a strategic material policy with regular monitoring of the milestones achieved.

4.2. Need for demand side interventions

There has been a regular push from successive governments in terms of incentives to assist manufacturers in setting up capacities to produce strategic military materials. However, to seed the adoption of indigenous military materials, demand side incentives, such as minimum order guarantees, exclusive and/or long-term agreements with DPSUs, should be assured.

4.3. Dual use applications

Industry players, both public and private, should work at identifying the key materials in defence that can be also used for other civilian applications. Examples of such materials include carbon fibres which apart from military applications are also used for making diving suits and thermal clothing. There are numerous applications of these components/ sub-systems for civilian and commercial purposes and the larger market size will attract domestic manufacturers.

4.4. Rationalisation of specifications and certification

There is a need for rationalisation of the standardisation process for technical and functional specifications in defence and aerospace manufacturing and documenting equivalent standards to convert other prevalent global standards without the need for recertification. The success story of the European Defence Standards Information System (EDSIS) can be replicated in the Indian context to create an all-encompassing single standardisation process. Certification standards also must be tweaked towards globally accepted practices wherein materials to be used are certificated and not the product made from the material. This will eliminate the need for recertification of platforms and give the designers the freedom to choose from a range of certified materials.

4.5. Pilot production unit

Manufacturers should identify existing materials in their portfolio whose specification can be reconfigured to meet military standards/ requirements without making major changes in the production lines. Once identified and subsequently when the necessary technology is developed, manufacturers can set up a pilot production unit in their existing production unit to gain the required market exposure along with the certifications before setting up a dedicated unit.

4.6. Self-reliance index

It is also important to monitor the import dependency of each DPSU and OFB facilities on imported raw material. A metric like self-reliance index for each DPSU should be created, which would measure the level of raw material import against total raw material requirement. This metric should be published every quarter by DDP. This will create a healthy competitive environment for DPSUs to reduce their import dependency for raw material.

Table of abbreviations

AMS	Aerospace Material Specifications
AS	Aerospace Standards
ASSIST	Acquisition Streamlining and Standardisation Information System
ASTM	American Society for Testing and Materials
BIS	Bureau of Indian Standards
CEN	European Committee for Standardisation (Comité Européen de Normalisation)
CMC	Ceramic Matrix Composites
DAP	Defence Acquisition Procedure
DDP	Department of Defence Production
DGAQA	Director General of Aeronautical Quality Assurance
DGQA	Directorate General of Quality Assurance
DIN	Deutsches Institut für Normung
DMRL	Defence Metallurgical Research Laboratory
DoD	Department of Defence
DoS	Department of Standardisation
DPP	Defence Procurement Procedure
DPSU	Defence Public Sector Undertakings

DRC	Democratic Republic of Congo
DRDO	Defence Research and Development Organisation
EDA	European Defence Agency
EDSIS	European Defence Standards Information System
EDSTAR	European Defence Standards Reference System
GoI	Government of India
HAL	Hindustan Aeronautics Limited
MIDHANI	Mishra Dhatu Nigam
MoD	Ministry of Defence
MoQ	Minimum Order Quantity
MSSC	Material Standardisation Sub-Committee
NIIO	Naval Indigenisation and Innovation Organisation
OEM	Original Equipment Manufacturer
OFB	Ordnance Factory Board
ToT	Transfer of Technology
TPCR	Technology Perspective and Capability Roadmap
UNS	Unified Number System

Endnotes

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