POWDER METALLURGY ASSOCIATION OF INDIA

PMAI

ISSN-0377-8452 JANUARY-APRIL 2021

Contents

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Editorial

2021: Opportunities and challenges, is the insightful lead article by PMAI president, Mr.Aniket Gore; dealing with the highlights of Indian Budget, PMAI activities, Outlook and Challenges of Automotive Sector, Decarbonizing India and Electric Mobility. I am sure you will enjoy reading this article.

In the COVID 19 pandemic environment, PMAI responded well and pivoted to organize digital courses. PMSC-20 was held during 26-29 Sept.2020 in partnership with College of Engineering Pune. A new course, PM Product-Tool Design Process, was conducted during 9-10 March 2021 by Mr. Sanjay Rastogi. Both digital courses were extremely well received.

We are extremely sad to report the demise of one of PMAI's Pillars, our past President Dr. T Rama Mohan. My interaction with him started when he was M.Tech., student at I.I.T., Bombay and I used to take PM classes. Later he joined our IIT faculty. Dr. Rama Mohan was initially involved in IIT social and cultural activities. He was an extremely popular teacher, and surrounded by students whether in the Metallurgy department, hostel or home. He was Hostel warden, and has personally and professionally mentored many students who continued to keep active contact with him through his life. Late Manohar Parrikar (who later became the Defence Minister of India) always heeded Dr. Rama Mohan's call to attend and support PMAI activities.

His family was also gracious enough to contribute to the cultural activities at National and International Conferences at I.I.T. Bombay and other parts of India organized by PMAI. Even after his retirement and despite face health issues, Dr. Rama Mohan used to come regularly to PMAI office at Mumbai. He also contributed to the Mega event APMA 2019, Organised by Past President N. Gopinath.

We salute his contribution to PMAI, his presence will be greatly missed!

P. Ramakrishnan

HOMAGE TO A GREAT COLLEAGUE, TEACHER AND RESEARCHER: PROF. T R RAMAMOHAN

It is extremely difficult to reconcile with the fact that Prof. TRR Mohan, who contributed to PMAI for over 4 decades, is no more. In his passing, PMAI has lost a very committed and sincere volunteer. Prof Mohan lived a simple life and attached great significance to spirituality. He endeared himself to academicians and industry. At this moment of grief, PMAI Members and Governing Council express solidarity with Prof Mohan's family. May Almighty give them the strength to deal with the tragic loss. The 'PMAI Family' salutes Prof Mohan for his invaluable contribution. His values and ideals will continue to guide us.

Om Shanti!

2021: OPPORTUNITIES AND CHALLENGES

A good reminder the year 2020 gave all of us is that the world is surprising. Things got worse faster than anyone anticipated, and the sharp recovery which was witnessed, aided by global liquidity, has also been unprecedented.

The Indian economy has disappointed over the last few years, unable to regain economic growth. The government has also not been as pro-business as most had assumed. However, over the last eight months, there has been a marked change in the governments approach. In the 2021 Budget the government has firmly re-established economic growth as its top priority and accepted the need to put the private sector at the heart of the growth agenda. For a government, which over the years has raised taxes on dividends, reintroduced capital gains taxes and put in various surcharges on the rich, to not raise any taxes in the 2021 budget, despite facing a significant dip in tax revenues signalled a definitive change in approach. This approach reflects the Centre's realisation that our tax rates are high enough, and that the centre can't get more money by constantly squeezing the same taxpayers. We need to expand the base, and growth is the only way to get the tax-to-GDP ratio higher.

The other refreshing announcement which broadly resonated with Modi's "Minimum Government, Maximum Governance" Promise made in 2014, was the announcement that Government will withdraw from all sectors of the economy, except a handful. Respecting our fiscal demands, our Government is committing to divest/merge or wind down hundreds of enterprises. It is also using strategic sales as the primary route. This will release huge resources, and improve productivity of capital across the economy. Assets will be put to better use and throw up large opportunities for the private sector. Let us hope there is a follow through by our bureaucracy on this stated intent.

There is also a shift in industrial policy. We have always disincentivised scale. In a 180 degree term from our Industrial Policy framed in 1956, for the first time, we are actively rewarding and trying to build global scale among our companies. The production-linked incentives (PLI) schemes seem well-designed, and should encourage global capacities in certain sectors where India has a right to compete. These schemes combined with the change in labour laws and lowering of corporate tax rates on new manufacturing assets to 15 per cent, give India the chance to attract global manufacturing.

The current geopolitical narrative, which necessitates the need for supply chain resilience and the search for alternatives— is also very conducive.

A consistently good agricultural performance, successful flattening of the COVID-19 infection curve, a good pickup in government spending, a good budget and government focus on "Atmanirbhar Bharat" which supports manufacturing in India are all expected to provide a meaningful boost to economic activity in India in 2021. Keeping in mind all the above factors, we are looking at 2021 with Guarded Optimism.

However, we must bear at the back of our mind that the possibility of negative surprises in 2021 cannot be ruled out. COVID cases are surging again and India is in the grip of a mammoth second wave. India is belatedly scrambling to secure vaccines, as it is increasingly clear that efficient vaccination of our population is most essential to ensure that normalcy prevails. Should the situation worsen, Oxygen supplies may be diverted from industry to healthcare, and this may impact production of steel, automobiles and consumer durables. While the government is principally against a prolonged hard lockdown, the possibility of supply chain disruption and muted demand can't be ruled out in the months ahead. We have to also guard against emergence of more contagious COVID variants, with the potential to evade vaccine-derived immunity. The possibility of early withdrawal of global fiscal stimulus can also present currently unfactored risks to India's growth prospects in 2021.

THE HIGHLIGHTS OF THE INDIAN BUDGET

The Indian Union budget 2021 -22 was presented on 1 February 2020 amid a challenging macro environment. With the first decline in nominal / real GDP in four decades, the Government walked a tight rope, balancing growth aspirations with fiscal restraint.

The budget had key announcements aimed at improving the country's fiscal situation, stimulating demand and incenting job creation through:

- Public and private investments
- Improving access to credit: by setting up a new asset reconstruction company and an asset management company to take over stressed assets of banks. This will clean the balance sheets of several institutions and allow them to start dispensing credit more actively.
- Setting up of a Development Finance institution to Finance Infrastructure Projects
- Equity Infusion of INR 200 billion (approx. 2.8 billion USD) to improve the Balance sheets of stressed Public Sector Banks.
- Robust Investment in Infrastructure Creation
- Concrete steps were also announced for improving the ease of doing business.

The most important fiscal highlight of our budget was that our government has come clean with its numbers, conceding that its fiscal deficit is at 9.5% of its GDP, as against a projection of 3.5% a year before. While dealing with the slowdown in the period 2018 – 2020, the government relied on "off-budget borrowings" by state owned firms to keep fiscal deficit number under control. Off budget borrowings have been used by multiple administrations in the past, in order to mask our true fiscal deficit.

The outstanding liabilities of the central government are expected to touch INR 136 trillion (190 billion USD). Interest payments as a percentage of revenue receipts are expected to touch approximately 45% in FY21 RE. (*source PWC).

The government will have to move rapidly to reduce their large fiscal deficit. The budget has targeted receipt of 1.75 trillion Rupees (22 billion USD) via disinvestment route in the coming year. Divestment of non-Core Public Sector Enterprises is a good move, because privatization will improve the performance of these enterprises, additionally ensuring a full stop to annual government subsidy handouts to them.

Expectedly, Financial Year 2021 (April 2020 –March 2021) is expected to see a GDP decline of 7.7%. The manufacturing sector is expected to decline by 9.5% and service sector by 8.8%. Private consumption is expected to decline by 9.5%.

The Agricultural Economy was a bright spot registering a growth of 3.4%, aided by a good monsoon, removal of lockdown restrictions for farming and efficient procurement of food grains. From an industrial perspective, sectors like healthcare, pharmaceuticals, technology (Education Technology, Financial Technology) and Telecommunications have shown growth potential during the pandemic period and are likely to witness increased investment and robust growth in the future. The pandemic has also led to higher preference for digital services and online transactions, thus promoting digitalization in many companies.

PMAI ACTIVITIES FOR 2021

At PMAI, we made a decision late last year to conduct all 2021 activities digitally. We have introduced a new course teaching principles of PM Tool Design. Our Governing Council Member and long term supporter of PMAI, Mr. Sanjay Rastogi, who was Director Engineering at GKN Sintermetals India, conducted the 2 day Digital course on March 9 and 10, 2021. The course was very well received and appreciated by 22 participants, and we are confident this will be a regular offering from PMAI.

Our PM short course will also be held, as we do each year in the second half of 2021. Additional new events are being ideated, and will be announced and actioned in 2021.

INDIAN AUTOMOTIVE SECTOR: OUTLOOK AND CHALLENGES

The automotive sector is at the center of our country's economic activities. It has suffered massive sluggishness in the past 3 years, after the introduction of GST, and the increased cost impact due to new safety norms, insurance regulations and the axle and emission norms. Here are the salient budget announcements impacting the automotive sector in India:

- The voluntary vehicle scrappage policy along with mandatory vehicle fitness tests will aid personal and commercial vehicle demand. It is expected that over 5 Million Cars (above 20 years) and 3 Million Medium + Heavy Commercial Vehicles (above 15 years) will need to be replaced generating good demand.
- Augmentation of public bus transport by about 20,000 buses is a positive for bus manufacturers.
- Customs duty rate has been increased on certain auto parts (such as ignition wiring sets, safety glass, parts of signalling equipment). This is in line with the Government's Aatmanirbhar Bharat initiative to promote localisation in auto spare parts manufacturing.
- Enhanced outlay for infrastructure – railways, metro rail, rural – development projects will benefit the commercial vehicle, construction equipment and tractor segment.
- The continued focus on building rural and agricultural infrastructure and prioritising agriculture credit growth will have a long-term positive impact on the rural demand for passenger, small and light commercial vehicles.

The COVID-19 impact has dented demand as is evident from the SIAM Sales data hereunder:

SIAM Production and Sales Data – April 2020 to March 2020 (FY21):

Production:

Passenger Vehicles, Commercial Vehicles, Three-wheelers, Two-wheelers and Quadricycle: 22,652,108 units, as against 26,353,293 units in FY-20, witnessing a Year on Year de-growth of 14.04%.

Domestic Sales:

Passenger Vehicles – 2,711,457 (decline of 2.25%)

Commercial Vehicles – 568,559 (decline of 20.7%)

3Wheeler Sales – 216,197 (decline of 66%)

2 Wheeler Sales – 15,119,387 (decline by 13.2%)

Exports:

Passenger Vehicles – 404,400 (decline by 38.9%)

Commercial Vehicles – 50,334 (decline by 16.6%)

3 wheelers – 392,941 (decline by 21.6%)

2 wheelers – 3,277,724 (decline by 6.9%)

Since the festival period in October 2020, demand for cars has been strong. January 2021 sales for Passenger Vehicles and 2 wheelers was better than that in January 2020. Waiting period for Maruti Suzuki cars is 3 to 8 weeks, and for some Hyundai, Kia Models is 3 months. All car makers are attempting to ramp up output.

The automotive industry in India are facing cost pressures and some supply chain challenges. Rajesh Menon, Director General of SIAM listed 3 key issues faced by car makers, namely rising prices of steel, unavailability of semiconductors and higher container charges.

A severe contraction, followed by a rapid increase in demand has led to demand supply imbalances. When combined with trade restrictions driven by geopolitics (China – Australia for example) this has led to a surge in prices for commodities.

The global price of steel has been rising based on tight demand - supply situation, as demand is improving faster than production, coupled with sharp increase in raw material prices. Prices of Iron Ore, the key raw material for steel production have soared globally driven by strong Chinese demand. This coincides with a dip in production of Iron Ore in India, especially at our mines in Odisha. Indian Iron Ore exports doubled in 2020 to 40 million tons, and over 95% of these exports were made to China.

Shortage of semiconductor chips is a global concern. They are used in new vehicles for areas including infotainment systems, power steering and brakes. In 2019, automotive groups accounted for roughly 10% of the 429 billion USD semi conductor market. Research Firm HIS Markit estimates that in Q1 2021 - 672,000 fewer vehicles (number includes 250,000 in China) will be built in due to chip shortage. Shortages are expected to worsen later this year. Consulting Firm Alix Partners estimates that the chip shortage will cut over 60 billion USD of revenue from the global automobile industry this year.

The origin of the global semiconductor shortage dates to early last year, when Covid caused rolling shutdowns of vehicle assembly plants. As the facilities closed, the wafer and chip suppliers diverted the parts to other sectors such as consumer electronics, which weren't expected to be hurt by stay-at-home orders. In fact these sectors thrived during the lockdown era. A 26 week lead time is needed to build chips before they are installed in a vehicle. Global demand for vehicles came back far faster than expected, while chip suppliers were continuing to divert resources away from the

automotive industry. They are now working hard to restore supplies, however, it may be several months before the demand supply situation normalizes.

Container shortages and resultant increase in freight rates are also a global phenomenon. An unexpected surge in global demand is compounded by Chinas need for fast return of empty containers to feed their shipment requirements. Container availability is short, there are logjams at Ports due to equipment shortages and other supply chain bottlenecks. Freight rates are high. It is widely expected and hoped that the container demand and supply situation and freights should stabilize in the second half of 2021.

It is inevitable that Indian Consumers will face price hikes for purchase of Passenger Vehicles this year. Delivery times for vehicles will also increase, if supply chain disruptions get prolonged. If we do avoid some of the macro risks stated earlier, economic momentum will be sustained and Automotive Sales for subsequent months of 2021 will continue to be robust.

As Electromobility gains momentum globally, it is important to review policy support and understand the policy tailwinds which will benefit Electromobility to thrive in India. I am touching upon some of these aspects hereunder.

GOVERNMENT SUPPORT TO ELECTRIC VEHICLES UNDER FAME II SCHEME:

Union Minister Nitin Gadkari elaborated the current support to Phase II of the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles in India (FAME India) in a written reply to the Indian Parliament (Lok Sabha) on Thursday, 11 February 2021. Here are the highlights:

- Total Budgetary Support of Rs. 10,000 crores (1.4 billion USD)
- Focus on supporting electrification of public and shared transportation.
- Support to 7000 e-buses, 55000 e-4 wheeler passenger cars, 500,000 e-3 wheelers and 1 million e-2 wheelers.
- Total 98 electric vehicle models: 32 two wheelers, 50 three-wheelers and 16 four- wheelers have been registered under the FAME India Scheme Phase-II as of February 8, 2021.
- Installation of 2600 charging points approved.
- Incentives provided by Government are in form of upfront reduction in Purchase Price. The incentive is linked to battery capacity, i.e. Rs. 10,000 (140 USD) /KWh for e-2 wheeler, e-3 wheeler and e-4 wheeler.

The present GST of 5% on electric vehicles is not proposed to be reduced further.

The Governments support to EV's is driven by the realization that India needs to move away from Fossil Fuels to Renewables. Indias import of Oil and Coal are a huge overhang on our fiscal situation. Additionally, the air pollution caused by Fossil fuels takes a huge toll on the country. India has 22 of the 30 most polluted cities in the world. COPD (Chronic Obstructive Pulmonary Disease) takes a million lives a year. Energy needs in India will increase sharply, and, India is transitioning with purpose from Fossil Fuels to Renewables to power its growing requirements.

GLOBAL MEGATREND – DECARBONISING THE WORLD.

There is a global call for treating the present Global Warning as a Climate Emergency.

To avoid the worst climate impacts, global greenhouse gas (GHG) emissions need to halve by the year 2030 and reach “Net Zero” by the year 2050. Net Zero emissions will be achieved when human caused GHG emissions are reduced as much as possible, and any remaining GHG emissions are balanced by measures such as Reforestation or through Capture and Storage. Leading global economies across the world including the U.K., Japan, Korea and 110 other countries have committed to become net Carbon Neutral between the years 2050 - 2060.

With the advent of the Biden Government, United States is expected to announce its commitment to net Carbon Neutrality soon. It is unclear if India will be announcing their target soon. As the second largest coal-producing and consuming country on earth, and third-largest emitter of greenhouse gases, India's transition from carbon-intensive resources is a critical front in the global climate change fight.

There is Global consensus that in order to reduce human caused GHG emissions, two areas have to be addressed on priority – Generation of Electricity and Transport. Hereunder, I will touch upon both:

FIXING INDIA'S FUEL DEPENDENCE

To move towards decarbonisation, India has to first address its Electricity Generation where India consumes most of its fossil fuels. India has largely built the infrastructure to provide electricity access to every citizen over the last seventy years. The country has done a commendable job of meeting its electricity demand with a fleet of robust power generation resources. Fossil fuel resources have been a critical contributor to this success story accounting for more than 75 percent of India's power needs.

However, due to a lack of indigenous fossil fuel resources, the country's energy systems are heavily dependent on oil and coal imports. This not only contributes to India's rising trade deficit but is also responsible for a growing subsidy burden for the Centre accounting for more than US$10 billion in FY 2019 alone. Additionally, India has to tackle a serious air pollution problem, caused primarily by the pollution from our thermal power plants and fossil fuel vehicles. For a country whose energy demand that is projected to double in the next 20 years, with electricity demand potentially tripling as a result of increased appliance ownership and cooling needs, there is an urgent need to migrate the current energy systems towards indigenous and environmentally sustainable resources. India is moving with purpose in this direction.

In a testament to India's growing demand for low-cost and locally manufactured power, Indian power minister R.K. Singh announced last year that the country would boost its domestic solar manufacturing base to reduce reliance on solar cells and modules imported from China. He also announced that renewables would replace the generating capacity from 29 coal plants slated to retire in the coming years.

State-owned enterprise Coal India — the largest coal-producing company in the world — announced that it will enter the solar value-chain business and launch a new renewable energy vertical. The company received board approval to establish an integrated solar wafer manufacturing facility in December. There are also reports that other state-owned companies could be required to establish a domestic polysilicon supply chain.

India has set the world's boldest ambition for renewable energy addition—175 GW of renewables by 2022. In addition to granting renewables must-run status through the pandemic, the government launched multiple tenders for new renewable energy projects to meet India's future energy demand. Not only did the auctions continue but the country also saw a series of record-low solar bids. In February 2021, a 500-megawatt solar auction held by utility Gujarat Urja

Vikas Nigam Limited set a new record for the lowest price in India of INR 1.99 ($0.0269) per kilowatt-hour. The cost of electricity storage has also been dropping rapidly.

Speaking at the United Nations Climate Ambition Summit in mid-December, Prime Minister Narendra Modi declared that India is on track to reach, and ultimately exceed, its ambitious renewable energy targets. India's total installed capacity of renewable energy, not including hydropower, currently stands at 90 gigawatts. According to a review by the Ministry of New and Renewable Energy, the total capacity of renewable energy projects already commissioned or in the pipeline at nearly 167 gigawatts.

Prime Minister Modi recently announced that he expects the country's clean energy capacity to reach 220 gigawatts by 2022 with the inclusion of hydropower — besting the country's 175-gigawatt target. If India realises this ambition, it will account for over 20 percent of renewable deployments worldwide and fossil fuels will account for just one-third of the country's power generation capacity before 2030. The rapid decarbonizing of the power sector will also accelerate the country's contribution in overachieving its “2o C compatible” rated Paris Agreement climate action targets.

India's target of 450 GW renewable energy by 2030 is now viewed as achievable and may even be exceeded. After electricity generation, the largest use of fossil fuels in India is in the transport and mobility sector.

For Commercial Ventures revolving around Mobility, wherever there is a case for proven and attractive payback, institutions are willing to change to Electromobility. Using electricity for train movement is far cheaper than using diesel, and the Indian Railways are moving towards full electrification. The Indian Railways electrification, when complete, will save consumption of an estimated 3 million kilo litres of diesel each year. Subsidies to state transport undertakings will drive sales of electric buses for intra-city operations.

In the 3-wheeler space, incumbent OEM's are launching e-autos, and low speed 4 seater e-rickshaws are also emerging as an attractive solution due to low operating costs. Cab aggregators or fleet operators will increasingly adopt e-cars, as these will enjoy better operational economies and subsidies. A cab aggregator e-car that runs ~50,000 km a year, for instance, can save about Rs 165,000 (USD 2,250) a year compared with Rs 35,000 (USD 450) for a personal e-car that runs ~10,000 km a year, as per some studies conducted recently.

ICE 2 wheelers are a very large consumer of petrol in India. 170 million ICE bikes are currently estimated to ply on Indian Roads. Total annual consumption of petrol by all these bikes is estimated at 30 - 35 million Kilo Litres annually. The 2 wheeler Market in India is currently in limelight for the slew of investments announced for E2W production. It appears that the E2W Segment is set for exponential growth from a medium term point of view, aided by favourable government policies, increase in competitive intensity and aggressive pricing in comparison to ICE scooters.

Recently, OLA Electric (OEL) announced an investment of Rs. 24 billion (30 million USD) to setup the worlds largest e-scooter factory with an initial capacity of 2 million Units, which can be ramped up to 10 million Units annually (15% of global capacity). OEL will be one of the most automated production sites with 5000 Robots and AGV's in action in India. OEL will have a high level of localised content which includes setting up their own battery plant in India. OEL aspire to achieve production of 10 million units in 2022 and have secured funding commitment for 2 billion USD. It is likely that OEL will follow a cash burn strategy to gain market share, and there is speculation that they will price their product comparable to ICE scooters. Range is speculated to be between 150 to 180 kms in regular driving conditions and OELs hope is that should be good enough to attract mass consumers.

Other E-Bike manufacturers also announced intended Capacity increases:

Ather – 25,000 units to 135,000 units per annum.

Okinawa – 90,000 units to 1 million Units in Few years.

Ampere – 50,000 units to 1 million Units in Few years.

Hero Electric – 70,000 units to 250,000 Units in Few years.

As cost of battery is expected to fall significantly from current USD250/kW-H and battery chemistry improves, E-bikes should take significant market share from ICE 2-wheelers in the coming decade. Even if 50% of the ICE volume is substituted by E-bikes over the coming 10 to 15 years, it will substantially help reduce fossil fuel consumption in this segment.

The OEL project progress and consumer acceptance is a key moniterable for Legacy 2 Wheeler OEM's. They understand the EV Drivers, but have been expecting a gradual E2W rampup. If the OEL E2W is able to find strong consumer acceptance over the coming 2 to 3 years, this would mean that E2W sales will ramp up much faster than ICE OEM's anticipated.

Based on the current realities, sales of personal electric cars will remain slow due to high acquisition and ownership costs, in the absence of demand incentives. Consumers willingness to shift from ICE to NEV's will depend on improvement of the charging infrastructure, range of battery, and access to reliable and non-hazardous battery chemistry.

The transition towards electric mobility offers India not only an opportunity to improve efficiency and transform the transport sector but also addresses several issues that the country is currently grappling with. The concerns regarding energy security, air pollution and rising current account deficit (CAD) on account of rising fossil fuel imports can be addressed with the uptake of electric mobility. India is a power surplus country and is currently witnessing lower Plant Load Factors due to lower capacity utilization. As per the conservative estimates, demand from electric vehicles (EV) could greatly improve the utilization factor of underutilized power plants, as charging pattern of EV users is considered to coincide with power demand during the non-peak hours in the country. The Government is moving with Purpose to replace old coal fired plants with renewable plants (primarily solar).

In this macro-environment, it is vital for our ICE dependent PMAI community, to keep a very close and continued track of developments w.r.t. Electromobility in India. At PMAI, we are actively engaging with institutions that are closely tracking Electromobility developments. We intend to periodically update our PMAI community with respect to progress of Electromobility in India and Globally. Please await our announcement concerning a new initiative in the near future.

I take this opportunity to wish you and your extended families good health.

Stay safe and best regards,

Aniket Gore

The data points and inputs presented in the article are all based on published material. I have merely connected the dots. Sources can be provided on request.

The author is an entrepreneur whose business supplies critical raw material and Capital Equipment to the Powder Metallurgy, Ceramic, Graphite and other Speciality Industries.

He is the Current President of the Powder Metallurgy Association of India.

He is also an active investor in Indian equities and companies in the start-up ecosystem in India.

He can be reached at president@pmai.in

POWDER METALLURGY SHORT COURSE-20

PMSC 20

26th–29th September, 2020

A four-day short-term course on powder metallurgy "Powder Metallurgy Short Course-20 (PMSC20)" took place from 26-29 September 2020 in the virtual mode and governed through Department of Metallurgy and Materials Science, College of Engineering Pune Campus. The program was organized by PMAI in collaboration with Department of Metallurgy & Materials Science College of Engineering Pune. Dr. S.P.Butee, Co-Convener and HoD Metallurgical Engineering COEP welcomed the participants and briefed about workshop. He also introduced various activities and happenings of the department to the people present in the inauguration. Mr Aniket Gore, President, Powder Metallurgy Association of India gave introduction about PMAI and the activities housed under the flagship. Dr. Vaishali Poddar gave instructions for online mode of communication during PMSC 20 and later Dr. S.P.Butee proposed vote of thanks. Invited talks covered various aspects of powder metallurgical technology. The multiple invited talks were delivered by eminent speakers and covered various powder metallurgy and its application related topics as tabulated in Table 1.

Table 1: Topics of the invited talks covered by various speakers at PMSC 20.

Sr. No.	Topic	Name of the Speaker
1	Overview of Powder Metallurgy and Particulate Materials Technology	N.L.Chandrachud, Consultant
2	High Density, High Performance PM Materials Processing	N.L.Chandrachud, Consultant
3	Thermal Methods of Powder Production for PM	Dr. T . Mahata, BARC
4	Mechanical and Solution Methods of Powder Production for PM	Dr. K. Murli Gopal, Novoken Innovations
5	PM Porous Materials	Dr. K. Murli Gopal, Novoken Innovations
6	Manufacturing Techniques for Commercial Iron Powders	M. Nipanikar, Hoganas India
7	Powder Characterization	Prof.P.Ramakrishnan, Emeritus Professor, IITB
8	Maintaining Quality in PM Manufacturing	Rajendra Sethiya, GKN
9	Design and fabrication of Tooling for PM	Sanjay Rastogi, Consultant
10	Furnaces for sintering & heat treatment	N. Gopinath, Fluidtherm
11	Metal Injection Molding	Prof Parag Bhargava, IIT B
12	Consolidation of Powders:Binders, Lubricants & Sintering Aids	Dr. Syam Babu, BARC
13	Sintering of Some Commercial Ceramics	Dr. Rama Mohan Tallapragada, Consultant
14	Fabrication / Shaping Methods for Advanced Ceramics and Composites	Dr. Deep Prakash, BARC
15	PM parts Heat Treatment	Dr. N.B. Dhokey, CoEP
16	Thermal Consolidation of Powders- Sintering Fundamentals	Dr. N.B. Dhokey, CoEP
17	Powder metallurgy of Bulk Metallic glass Composites	Dr.Bhaskar Majumdar, DMRL
18	Bond Matrices in Diamond Cutting Tools	Dr. Vivek Singal, Consultant
19	Friction Materials	Dr. Malobika Karanjai, ARCI
20	Biomaterials	Dr. Malobika Karanjai, ARCI
21	Tungsten Alloys in Defence and Aerospace Industry	Mr. Bijoy Sarma, Consultant
22	Overview of PM Standards	Dr. V. S. Poddar, COEP

Each session comprised of dedicated discussions, challenges and opportunities in powder metal lurgy technology development. Overall there were about 17 participants attended this course which were drawn from diverse industries viz. Heavy Alloy Penetrator Project, Trichy, Godrej & Boyce Mfg. Co. Ltd., Federal Mogul, Tenneco, Yogeshwar Engineering, Danfoss Power Solution India Pvt. Ltd., Sintercom India Limited, Aloft Specialities, Sarda Metal Powders, PP Patel and Company. The course feedback was collected from all the participants and the overall rating for the course came out to be 4.1 out of 5. Few suggestions were given by the participants to further improve the course effectiveness viz. case studies related to PM to be discussed in more details, elaborate information on basic set up needs of PM related functioning, and information about tolerancing practices in case of as sintered components having different geometries. Also, based on the courses taught, online examinations in between the talks were conducted and participants had responded very well to this.

Snap of the valedictory function which took place on 29 September 2020.

TWO DAY VIRTUAL COURSE ON PM PRODUCT - TOOL DESIGN PROCESS

PMAI organized an online course on Tool Design for Powder Metallurgy process during 9th and 10th March 2021. The course was conducted by Mr. Sanjay Rastogi an expert having 32 years of experience in automotive Industries, out of which 27 years in Powder Metallurgy field working for companies like Sundram Fasteners, FederalMogul, GKN Sinter Metals, with most of the design centres of major OEMs in India & abroad. In his role at GKN as director Engineering, was responsible for engineering functions including tool manufacturing for two plants in India and one in South Africa.

The course covered fundamentals and series of exercises explaining the intricacies of tool design for PM. It has been well attended and acclaimed.

Topics covered in Course

Basics of PM

1. Powder
2. Compaction
3. Sintering
4. PM Products - Design &Shape

Compaction - Fundamentals

Tool Friction and M/Q ratio

Elasticity of tools & product quality

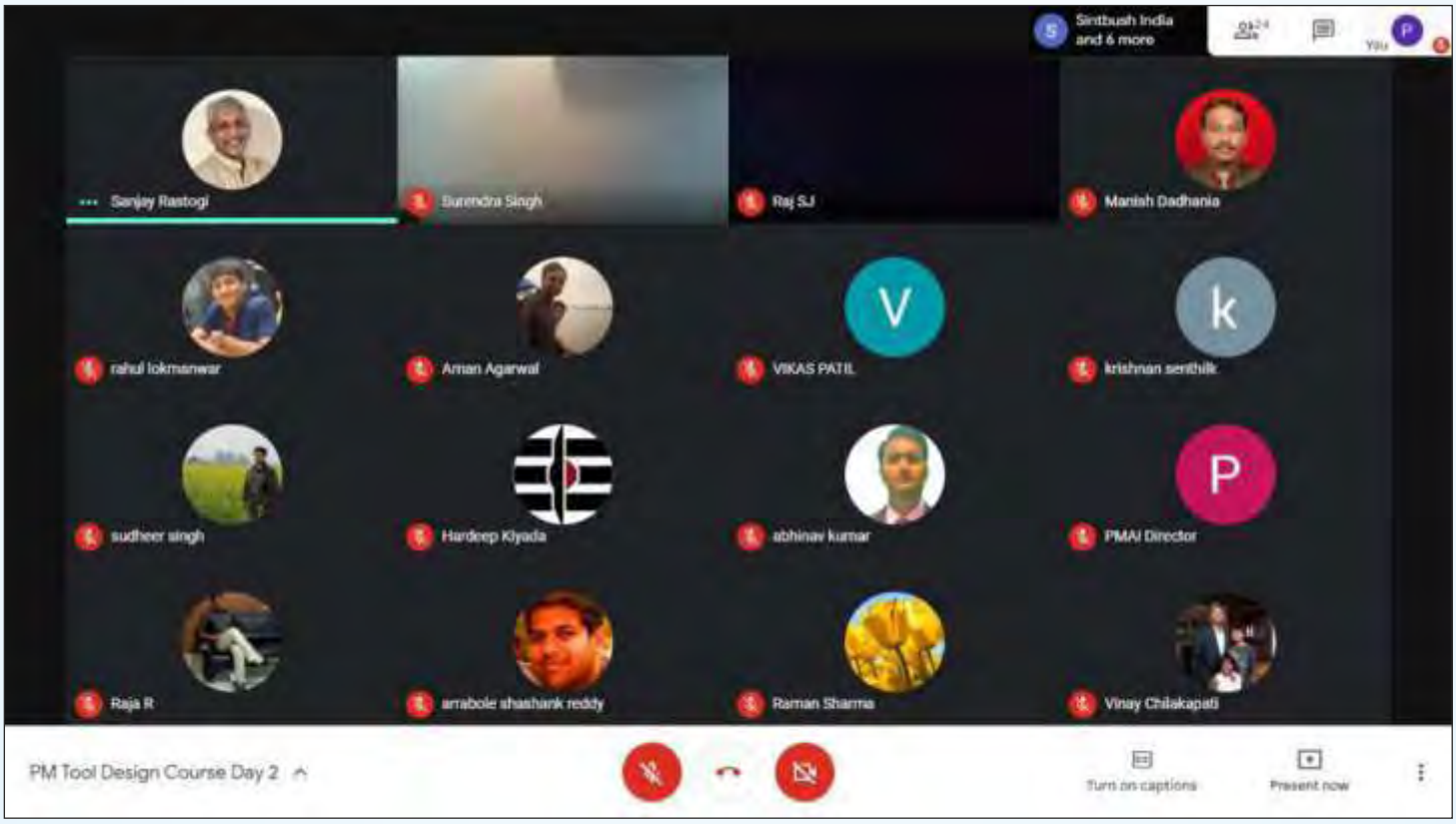
Adapter - Link between tool and press

Tool Design Process - Product to tool

Tool Design Process - General assembly

List of Attendees

Mr.Vikas Patil	Sintercom India Limited, Pune	Raman Sharma	Cosmo Ferrites, Parwanoo
Mr. Vinay Chilakapati	Innomet Advanced Materials, Hyderabad	Prashant Bhat	Taegutec-india, Bengaluru
Hardeep Kiyada	Time Futuretech, Rajkot	Santosh R N	Taegutec-india, Bengaluru
Mr. Surendra Singh	RVB Shorlube, Kanpur	Arujun Shetty	Taegutec-india, Bengaluru
Mandar Pimple	Sintbush India Pvt Ltd, Palghar	Senthil K	Taegutec-india, Bengaluru
Kumar Abhinav	Tenneco Federal Mogul, Bhiwadi	Krishnaprasad Bhat	Taegutec-india, Bengaluru
Dalvir Singh	Tenneco Federal Mogul, Bhiwadi	Rahul Lokmanawar	Hoganas India Pvt Ltd, Pune
Surender Kumar	Tenneco Federal Mogul, Bhiwadi	Manish Dadhania	Precision Sintered Products, Rajkot
Sudheer Singh	Tenneco Federal Mogul, Bhiwadi	Mr.Sugumar G	Samvardhana Motherson Innovative Solutions, Puducherry
Naveen Kumar	Tenneco Federal Mogul, Bhiwadi	Aman Agarwal	Nuclear Fuels Complex, Hyderabad
Salesh Sharma	Cosmo Ferrites, Parwanoo	A Shashank Reddy	Nuclear Fuels Complex, Hyderabad



OBITUARY

Dr. Tallapragada Raja Rama Mohan

(05-09-1942 to 15-04-2021)

Born in Guntur, Andhra Pradesh on 5th September 1942, Dr. TRR Mohan completed his schooling at M.G. High School and his graduation from Annamalai University in Chidambaram. He completed his Post Graduation and Doctorate in Metallurgical Engineering at IIT Bombay. After completing his PhD he continued as faculty in same department.

Dr. Tallapragada Raja Rama Mohan, popularly known as TRRM, served in the faculty of Department of Metallurgical Engineering and Materials Science, Indian Institute of Technology-Bombay, Powai, Mumbai, for over 35 years (1969-2005). He was In-charge of the Powder Metallurgy and Ceramics Laboratories, and was active member of the Powder Metallurgy and High Temperature Materials Centre. During his sabbaticals he took assignments as a visiting professor at University of Southern California, Los Angeles, USA (1978-80), and Oklahoma State University at Stillwater, USA (1993-94). He was actively involved in the teaching, research and development, sponsored research and industrial consultancy, in the areas of Advanced Ceramics, Powder metallurgy, Particulate Composites, Diamond Tools and Biomaterials. His contributions to teaching and research on defects chemistry of solids, especially to low temperature sintering of Advanced Ceramics, have inspired many of his proteges to apply it in their research even today at various institutions around the world.

He was an active Life Member of PMAI since its inception from 1973, and served in various capacities as Joint Secretary, General Secretary, Vice President and President and was honored as the Fellow of PMAI. He was also active in Indian Ceramic Society and was the Chairman of its BMR Chapter. He was active in American Society for Materials and a life member of Society for Biomaterials & Artificial Organs of India.

He organized several National and International Conferences and Industry Oriented Workshops under the aegis of PMAI, Indian Ceramic Society, ASM. He edited three books Fine ceramics, Powder Metallurgy in Automotive Applications II and PM and Allied Industry in India. He supervised 22 PhD and 107 MTech, several hundreds of BTech students and published over 100 papers in Conference proceedings and International Journals. He had participated in the Indo-US and Indo-Israel collaborative research projects, and presented papers in the Annual technical meetings of the American ceramic society and American Powder Metallurgy Institute. He continued as an active academician and consultant till he breathed his last. He is survived by his loving family: wife Laxmi, 2 daughters and sons in law, and 2 grandchildren. His family, students, colleagues and friends deeply condole his demise and pray for his Sadgati!

Om Shanti.