TCP AMT Strategic Work Plan, 2018-2023

The Strategic direction for TCP-AMT continues to focus on fuel economy improvement of vehicles by accelerating adoption of advanced materials for lightweighting, friction reduction, and waste heat recovery. we have achieved significant progress in all areas. The friction reduction surface has achieved 2% fuel economy gain using standard engine tests, this means reduction of 700Mb/yr of oil and 0.7Mton carbon emission. Continual improvement in fuel economy will further reduce petroleum consumption and CO_2 emissions worldwide, providing efficient transportation technologies to meet the needs of our society.

High level overview of future strategy: COP21 pledged significant carbon reduction in the next ten years to curb global temperature rise to less than 2 degrees. Transportation accounts for 16% carbon emission worldwide. The legacy vehicles fleet stood at 1.2B vehicles in 2014, while the world produces about 85M new vehicles annually. The average in-use life of cars is about 14 years. The vehicle population is projected to grow to 2B by 2035. Given the cost of vehicle ownership is decreasing and the rate of vehicle use may increase, the resulting increase in oil consumption and carbon emission is likely to put pressure on the world economy. Therefore, continual increase in fuel economy is a must yet a significant opportunity. Spurred by government regulations, such as the US CAFÉ standard of 54.5mpg by 2025 and EU standard calls for 57.4 mpg (4.1L/100km) by 2021, the engine technology is accelerating towards higher fuel efficiency. This has been and will be the AMT focus and we will continue our work to support this trend by developing the necessary materials technologies. We are working with original equipment manufacturers, and the tiered supply base including raw providers, to identify gaps and develop measurement standards to facilitate the commercialization of new materials technologies. Our current membership stands at 9 countries and over 25 research Institutes, forming a global network of experts. Austria and Brazil are joining the AMT at this time.

Current AMT program:

1) Friction surfaces (Annex IV): surface technology including surface texture, DLC coatings, and low viscosity lubricants. The newly developed low viscosity lubricant has achieved 2.4% fuel economy improvement in standardized engine dynamometer tests, used to certify fuel economy efficiency.
2) Thermoelectric materials (Annex VIII): measurement standards on materials and devices have been developed for waste heat recovery with potential of 3-5% fuel economy improvement.
3) Model-based coatings (Annex IX): model-based coatings cooperative research coupling models and experiments have revealed multiscale influence of roughness on damage mechanisms. The computation tools have been developed and verified.
4) Multi-materials joining (Annex X): a task plan has been established and initial materials procured for comparative benchmarking and database development of the mechanical performance of multi-material joints on a standardized set of materials (polymer composites, steel, magnesium and aluminum alloys). Multi-material joining was recently identified as a critical gap to vehicle lightweighting which can yield 6-8% improvement in fuel economy with a 10% reduction in vehicle weight.

AMT program for next 5 year term:

1) Friction reduction (Annex IV) will expand to include engine durability testing and models.
2) Thermoelectric materials (Annex VIII) will complete studies and conclude the Annex 2019.
3) Model-based coatings (Annex IX) will develop, validate, and utilize computational modeling tools to accelerate by 50% the development of new and improved coating designs for engine components in lubricated contacts. The results and guidelines can be utilized directly by the companies.
4) Multi-materials Joining (Annex X) will establish a multi-country, multi-organizations mechanical performance test program to generate a database for 14 or more joining methods of the standard material set. The data base will be made available to the industry.
5) Potential new Annexes to address the following technical challenges:
   - Green materials insertion for vehicle application: environmental friendly materials such as biodegradable fluids, biofuel, polymeric composites, and their test methodology,
   - Surface quality control through advanced materials manufacturing processes, machinability, and finishing,
   - Materials and material test methods for waste heat recovery systems, compatibility with new fuels,

- Topics member countries interested in proposing as time evolves or collaborative topics with other TCPs.

6) Conduct material technology assessments on new materials technologies; exchange technical information through technical symposia; issue topical reports on materials technology; participate in IEA transportation activities and collaborate with other Implementing Agreements and other world organizations.

Scope: AMT focuses on selected material technologies to promote fuel economy, emission reduction, global warming mitigation, and facilitate the insertion of environmentally friendly and sustainable materials.

Mission: The mission of AMT is to conduct materials research and to facilitate and accelerate the transitioning of new materials into vehicles and their components to achieve fuel economy improvement. This include the development of standard test methods, standards, testing, and demonstrations, and design guidelines and materials technology selection guides.

Anticipated output and impact:

1) Applying the surface materials technology developed in Annex IV and using ultra-low viscosity lubricants developed, we anticipate reaching 4% fuel economy improvement at the end of next term. This will have significant impact on the oil consumption and carbon emission.
2) More efficient and cost-effective thermoelectric materials will emerge as a result of the standards set by the Annex VIII, making waste heat recovery viable for trucks and other applications, improving fuel efficiency.
3) The model-based coating research will provide guidelines for future coating solutions to be used in engine components with enhanced durability and performance. The new guideline could be significant in lowering the cost of coating; and enlarging the global application potential
4) The materials community has made great strides in introducing new materials such as advanced high strength steels, carbon fibers, etc. The methods to join dissimilar materials efficiently in vehicle structures remain a major barrier. Guidance for selection of appropriate joining methods has long been sought. Annex X aims to provide an open technology-based guidance on joining dissimilar materials for vehicle technology, accelerating the development of multi-materials vehicles with higher fuel economy.
5) We anticipate Brazil, Austria, South Africa, and Thailand may join IA AMT in the future.

Added value, importance, strategic relevance

TCP AMT establishes a materials expert network among America, Europe, and Asia Pacific regions to exchange information and work together towards improved fuel economy technologies to reduce carbon emission, conserve petroleum resources, facilitate materials exchange and share the research results among participating countries. By joining together in working on the TCP program outlined above, knowledge, expertise, and facilities are leveraged by as much as 20 to 1. AMT practice personnel exchanges and training for participating members to accelerate their technical developments, enhance economic development. This aligns closely with IEA's mission (energy security, economic development, environmental awareness and engagement worldwide).

Signatory countries

Germany -- Bundesanstalt für Materialforschung und –prüfung (BAM)
United States -The United States Department of Energy (DOE)
Canada – CanmetMATERIALS, Natural Resources Canada
China – Lanzhou Institute of Chemical Physics, Chinese Academy of Sciences
– Shanghai Institute of Ceramics, Chinese Academy of Sciences
United Kingdom – University of Sunderland, UK (designated by DTI)
Australia- Curtin University, Perth, Australia (designated by the Dept of Resources, Energy, & Tourism)
Finland – TEKES, Finland (VTT designated by TEKES)
Israel – Technion, Haifa, Israel (designated by Ministry of National Infrastructures)
Korea – Korea Institute of Energy Technology Evaluation and Planning (KETEP)
Austria – Österreichische Tribologische Gesellschaft – ÖTG, pending IEA official approval
Brazil -- Universidade Federal do Rio Grande – FURG, pending IEA official approval