IEA TCP AMT
MULTIYEAR OPERATING PLAN

IMPLEMENTING AGREEMENT
FOR A CO-OPERATIVE PROGRAMME ON
ADVANCED MATERIALS FOR TRANSPORTATION APPLICATIONS

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An addendum to the AMT Implementing Agreement

The Implementing Agreement on Advanced Materials for Transportation (IA-AMT, hence forth referred to as AMT) Multiyear Operating Plan

Introduction

This Multiyear Operating Plan (MOP) has two purposes: to clarify the AMT's operating procedures; and to create an official record of the process and procedures so that future changes can be made from. This plan includes short summaries of all the active annexes and their work plan at the time. Updates will be issued when needed.

Financial operation of AMT

AMT operates on a task-shared basis. Each Annex defines the technical objective and work plan with participants through consensus. The tasks are assigned to the participants and participants are responsible to carry out the task. Each participant is responsible for funding of the task. There is no common fund or dues collected from countries or entities. In the rare instance that if a Task or an Annex was proposed and approved by the Executive Committee in unanimity to operate on a cost-shared basis, (i.e. every participant provides a yearly sum to create a common fund, and awards a contract to an institute or research organization or a university to carry out the specific project), participation will be entirely voluntary. The new Annex Leader shall contract or designate an operating agent as described in the Implement Agreement text. Under this situation, reports, accounting, hiring, staff, termination, liability will be governed by the implementing agreement language (IA text article 5 and 7).

Participation in annexes and information dissemination protocols

When a country joins AMT, participation of at least one Annex is required. The participation in the annex or annexes is submitted in the agreement by the new member country to the IEA Executive Director. Every time the country joins a new annex or withdraws from an Annex, official notice will be sent to the IEA Secretariat to update the official record.

An Annex is the basic working unit of the AMT. Each Annex has considerable leeway to set its own goals and rules of engagement with unanimous consensus of all participants, according to the language of the Implementing Agreement. This shall be written into the annex document and approved by the Executive Committee. Information such as sample identity, test method procedures, and resulting data are available only to the contributing members of the annex. The final report of the project, after approval by the Exco is available to all members of the Implementing Agreement. Proprietary data from industrial companies are protected from release unless so authorized by the company in writing.

AMT website

AMT uses a website for communication to the general public interested in the goals and activities of the Implementing agreement. A section of the webpages also serves as a communication focal point among the participants.

The website www.tcp-amt.org is open to the public to communicate the AMT activities. It also has a password protected members-only webpage in which the executive committee meeting minutes, Annex reports, current issues and future plans, are described. There is a three-year delay on the webpages on all technical presentations (unless consented and released by the presenter). After three years, the technical presentation files will be placed under the public domain webpages.

Each Annex has its own webpage. In addition, a password-protected webpage can be used by the Annex participants if the Annex decides to use the webpage for communication. The private webpage is open only to the annex participants, the Chairman, the Vice-Chair, and the Operating Agent of the IA (if one is duly appointed).

AMT Strategic plan

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 includes the development of standard test methods, standards, testing, and demonstrations, and design guidelines and materials technology selection guides.

The Strategy Plan for 2017-2023 for the Implementing Agreement for *A Program of Research and Development on Advanced Materials for Transportation Applications* (AMT) is available to serve as a guide/roadmap for the AMT activities for the duration with the aim to develop critical materials technology for fuel economy improvement.
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.

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) (CP)
United States -The United States Department of Energy (DOE) (CP)
Oak Ridge National Lab (ORNL)
George Washington University (GWU)
Canada -Natural Resources Canada (CAMET Materials Technology Lab) (CP)
National Research Council of Canada (participating Institute)
China - Lanzhou Institute of Chemical Physics (LICP), CAS (CP)
Shanghai Institute of Ceramics, Chinese Academy of Sciences (CP)
City University of Hong Kong
United Kingdom – National Physical Lab., UK (CP) (designated by DTI)
Australia- Curtin University, Perth, Australia (designated by the Department of Resources, energy, and tourism)
Finland – Finnish Funding Agency for Innovation (TEKES) (CP)
VTT, Helsinki, Finland (designated by TEKES)
Israel – Technion, Haifa, Israel (designated by Ministry of National Infrastructures)
Korea – Korea Inst. of Energy Technology Evaluation and Planning (KATEP) (CP)
Participating institutes:
Korea Electrotechnology Research Institute (KERI) (CP)
Korea Automotive Technology Institute (KATECH)
Korea Institute of Materials Science (KIMS)
Research Institute of Industrial Science & Technology (RISE)

Countries joining AMT with application pending:
Austria– Österreichische Tribologische Gesellschaft – ÖTG, pending IEA official approval
Brazil-- Universidade Federal do Rio Grande – FURG, pending IEA official approval

<u>Fuel Economy of Vehicles</u>

Majority of petroleum in the world is used in fueling vehicles for transporting people and goods. As the world population grows, the demand for liquid fuel rises accordingly. Fuel economy improvement, therefore is a critical factor in oil consumption, carbon emission, and global warming. Worldwide government regulations, such as the CAFÉ standards in the US (raising the fuel economy to 54.5mpg in 2025) are providing impetus to accelerate the fuel economy improvement. The technologies under consideration are:

1) Alternative propulsion powertrains (fuel cell, plug-in electric, and electric motor) are being introduced
2) Light weighting and maintaining vehicle safety
3) Improved energy efficiency of internal combustion engine
4) Novel mass transportation systems
5) Autonomous vehicles

We have examined the material technologies required to implement the next generation of transportation technology; several classes of material technologies are attractive for AMT activities:

I) Weight reduction by substitution of strong, lightweight materials:
   - Magnesium and its alloys
   - Aluminum and its alloys
   - Titanium and its alloys
   - High strength steels
   - Polymer nanocomposites, and
   - Low cost carbon fiber composites
   - Multimaterials joining

   Other considerations for lightweighting materials include recycling, sustainability, environmental friendliness, lower carbon foot-print manufacturing, etc.

II) Materials property enhancement in meet the future engine design criteria, including combustion, durability, and fuel economy.

III) Friction reduction via new materials and surface technologies
   - Surface texturing
   - Diamond like films with low friction characteristics
   - Self-lubricating composites or surface layers/coatings
   - bonded organic friction reduction films
   - Bonded inorganic friction reduction films, and
   - Nano-sandwich multilayer films and coatings

Weight Reduction via Materials Substitution:

While fuel economy of vehicles depends on many factors such as driving habits, fuel technology, parasitic energy losses, aerodynamic drag, transmission gear ratios, and combustion efficiencies, etc., vehicle weight is always important. For a 10% reduction in vehicle weight, a fuel economy improvement of 6-8% is achievable with significant carbon dioxide reduction (depends on driving conditions and vehicle designs). The important issue is consumer acceptance in terms of crash worthiness, vehicle stability, durability, aesthetics, acoustics, and purchase price and repair costs. Candidate materials are: titanium, aluminum, magnesium, high strength steel, polymer nanocomposites, and low cost carbon fiber composites. In some markets, comfort and roominess are important, and weight reduction allows higher fuel economy for the same size. To reach a futuristic target of 100 miles per gallon fuel economy, the vehicle will require many fundamental design changes, among them, 50% vehicle weight reduction by material substitution appear in most projections. Furthermore, reduced weight is critical to the adoption of lean energy propulsion systems, such as plug-in hybrid electric vehicle (PHVEs), and hybrid electric vehicles (HEVs). The range of such vehicles is directly dependent on weight. Additional benefits include reduced costs for battery size for a given driving range.

Materials in this category have other advantages. One is ease of manufacturing and good formability. Fiber composites and nanocomposites have high toughness and stiffness, resulting in better protection in crash tests. Magnesium and titanium alloys have superior specific strength, and high fracture toughness, suitable for engine components as well as structural parts. One of our current annexes is in this area.

For the materials in this category, specific material dependent technical barriers will need to be overcome for its use in vehicles, for example, magnesium alloys need low cost galvanic corrosion protection, titanium alloys need lower machining cost, carbon composites need much lower cost carbon fibers, clay-infiltrated polymer nanocomposites requires test methods to measure the dispersion efficiency of the clay particles

The availability of nanomaterials can have a far-reaching impact on many potential transportation applications (weight reduction, biodegradation, self-repairing, property change with pressure, etc.). AMT is interested in this class of materials as they evolve.

Friction réduction via surface technologies

Current parasitic energy losses in cars and trucks are substantial. Discrete surface textures have proven to be effective in reducing friction losses substantially in isolated cases. Under annex IV, progress has been made to develop design guidelines for such surface modification technology.

Surface texture alone, when applied to real engine component parts, has potential durability issue under cyclic loading. A protective film such as diamond like carbon (DLC) has been successfully demonstrated to enhance life under such conditions.

To further enhance the friction reduction capability and durability targets, many OEMs are conducting research to introduce organic-inorganic friction reduction films in polymeric matrix coated on engine components.

With the introduction of ultralow viscosity lubricants worldwide, spearheaded by the Japanese OEMs, surface technologies may be increasingly important to prevent wear and fatigue from increased surface contacts. The important criterion in this technology is the integration of various surface technologies into a platform and tested in the engines.

Summary

AMT has developed a strategy to make progress towards the goals specified in this report to enable new material technologies for significant fuel economy improvements through weight reduction, friction control, and improved efficiency via novel materials.

The majority of our efforts for the upcoming term will focus on how to achieve the specific goals set out in the attached annexes.

Annexes of the Advanced Materials for Transportation Applications

ANNEXES PRESENTLY IN FORCE

ANNEX IV
Co-operative program on integrated engineered surface technology to reduce friction and increase durability

Annex VIII
Co-operative program on the development of thermoelectric materials for waste heat recovery in transportation industries

Annex IX
Co-operative program on the development of model-based design of tribological coating systems

Annex X
Co-operative program on multi-materials vehicle joining technologies

COMPLETED ANNEXES

Annex I Ceramics for automotive gas turbine engines
Annex II Co-operative programme on ceramics for advanced engines and other conservation applications
Annex III Co-operative program on contact reliability of advanced engine materials
ANNEX V Co-operative program on advanced corrosion protection technologies for structural magnesium alloys used in transportation industry
ANNEX VI Co-operative program on the development of low cost carbon fiber for automotive applications
ANNEX VII Co-operative program on the development, evaluation and standardization of methods for testing mechanical properties of nanomaterials for application in automotive industries

Publication acknowledgment:

"The report (paper) describes the work being conducted is part of the Implementing Agreement on Advanced materials for Transportation under the auspices of IEA" or "The activity described in this paper is part of Implementing Agreement on Advanced Materials for Transportation under the auspices of the International Energy Agency Technology Network".

The Implementing Agreement for a Co-operative Programme of Research and Development on Advanced Materials for Transportation Applications, AMT IA, functions within a framework created by the International Energy Agency (IEA). The views, findings, and publications of the AMT IA do not necessarily represent the views or policies of the IEA or of all of its individual member countries.

Current active Annexes

Annex IV - Cooperative program on integrated surface technology for fuel economy improvements for cars and trucks

1. Scope: Within the moving parts in engines, friction consumes significant amount of energy input. Some friction resistance is essential for the safe operation of the engine but there are parasitic energy losses can be reduced to increase fuel efficiency. The Annex focuses on R&D effort on designing surface textures, DLC, and bonded chemical films on engine surface to reduce friction and enhance durability.

2. Annex Participants

US:	Led by Dr. Stephen Hsu, George Washington University, USA (Chair)
China:	Led by Dr. Junyan Zhang, Lanzhou Institute of Chemical physics, CAS.
Australia:	Led by Dr. Gwidon Stachowiak, University of Curtin Australia.
Israel:	Led by Dr. Izhak Etsion, Technion, Israel
Finland:	Led by Dr. Kenneth Holmberg, VTT, Finland
UK:	Led by Dr. Mark Gee, NPL, UK
Germany:	Led by Dr. Carsten Gachot, Saarland University, Germany
Korea:	Led by Dr. Min, KATECK, Korea

3. Activities/accomplishments

Surface textures, properly designed, can induce fluid pressure build up within the dimples to provide a lift force under lubrication conditions, hence reducing friction. When the coefficient of friction (COF) is reduced to below 0.05, a typical hydrodynamic lubrication level, there is no solid-solid contact under steady state conditions, hence wear does not exist. This lift force on the contacting surfaces can be generated if the location, size, shape of the dimples are properly designed for the specific kinematic motions/speed/load of the contact. Under this Annex, design guideline has been developed to provide friction reduction for ring-liner, cam-lifter, and bearing contacts. The technology is being validated currently in engine dynamometer Sequence tests and full vehicle chassis dynamometer with an industrial partner. Concern on the durability of surface textures by our industrial engine manufacturers led to the formation of a subtask on shear stable diamond-like-carbon (DLC) coatings in 2014, consists of US and China groups. DLC improved durability significantly. When a bonded chemical film was deposited on DLC, durability was increased by an order of magnitude.

In 2013, some original equipment manufacturers (OEMs) have reported significant fuel economy increase (2-4%) by using ultra-low viscosity lubricants in vehicle driving tests. While some OEMs have employed material technology to fortify their engines to be more wear resistant, this is not the case for all OEMs. A new ultra-low viscosity lubricant classification of the Society of Automotive Engineers (SAE) has been established in 2013 (SAE0W-16). The concern of the industry is potential wear and fatigue damage due to thinner lubricant film thickness from the low viscosity at high temperatures, as indicated

by the high temperature high shear (HTHS) viscosity measurement at 150ºC. Surface textures may be a valuable tool to alleviate or eliminate wear concern. At the same time, the low viscosity lubricant has been validated by engine tests. A new subtask on ultralow viscosity lubricant to improve fuel economy was initiated in 2015.
Currently the Annex is conducting engine chassis dynamometer tests on the effect on surface textures on fuel economy and durability. In the next several years, the combination of ultralow viscosity lubricants and the surface materials technology will be systematically evaluated in engines with our industrial partners.

red ring in
chemical film

Annex VIII – Thermoelectric materials for waste heat recovery: an international collaboration for transportation applications

1. Overview of Scope: the objective of the Annex is to develop test methods for the evaluation of thermoelectric materials and to develop precision statements for the standardization of these methods.

2. Annex Participants:

USA:	Led by Dr. Hsin Wang, ORNL, USA
Canada:	Led by Dr. Yu-Chih Tseng, CANMET, Canada
China:	Led by Prof. Lidong Chen, Shanghai Institute of Ceramics, CAS, China
Germany:	Led by Dr. Jan Konig, Fraunhofer Institute for Phys. Meas, Germany
UK:	Led by Dr. Alexandre Cuenat, National Physical Laboratory, UK
Korea:	Led by Dr. H. W. Lee of Korea Electrotechnology Institute, Korea

3. **Activities**

International round robin study with the aim to improve the accuracy and precision of thermoelectric material properties measurement methods has been conducted, using current measurement methods. Results showed significant data scatter on thermal conductivity and other properties associated with the determination of ZT [$ZT=\sigma S^2 T/\lambda$], the figure of merit commonly used to gauge the performance of thermoelectric materials (S is the Seebeck Coefficient, λ is the thermal conductivity, σ is the electrical conductivity, and T is the temperature). A total of four international round robin studies have been conducted.

Three round-robin studies on bulk thermoelectric materials have been conducted and currently, the study has extended to include thermoelectric devices to establish a measurement base and standards on measurement methodology to eliminate bias and reporting of high efficient thermoelectric materials, only later failed to be reproduced.

The round robin study of thermoelectric materials is the first of its kind. The study reveals fundamental measurement problems in the laboratories around the world, leading to reporting of many "high efficiency" thermoelectric materials. The Annex now plans to standardize the test procedure through the ISO, paving the way for accelerating the discovery of low cost high efficiency thermoelectric materials.

Annex IX Model based design of tribological coating systems

1. Overview of Scope: the objective is to integrate modeling and coating testing to guide the development of next generation of advanced coatings for energy efficiency and durability in engines.

2. Annex Participants

Finland:	Led by Dr. Kenneth Holmberg, VTT, Finland (Chair)
Australia:	Led by Dr. Gwidon Stachowiak, University of Western Australia
US:	Led by Dr. Stephen Hsu, George Washington University, USA
Israel:	Led by Dr. Izhak Etsion, Technion, Israel
China:	Led by Dr. Lawrence Li, City University of Hong Kong, Hong Kong
UK:	Led by Dr. Mark Gee, National Physical Laboratory, UK
Germany:	Led by Dr. Carsten Gachot, Saarland University, Germany

3. Activities

Coatings are widely used in modern engines for friction and wear improvement, high temperature protection, and corrosion resistance. Coatings are usually developed empirically. A new Annex IX was established to develop coatings based on computational model results. Initial cooperative study conducted by 5 member countries combining new computation material science models and experimental studies on coatings suggested that surface roughness and surface defects influence friction and wear of coatings performance and failure modes. While this has been known empirically, the relationship to microstructure of the coating was not clear. We now have computational models that include microstructural features and have linked them to performance. While this is being studied in Annex IX, a parallel effort in Annex IV was conducting improving the shear resistance of coatings to enable much longer durability under lubricated conditions.

Annex X: Multi-materials joining technology

1. Overview of scope

This Annex was approved by the IEA AMT Executive Committee meeting in London, UK on June 4, 2013. The objective of this Annex is to develop joining methods of various lightweight materials to enable the assembly of an optimum light weight vehicle with high energy efficiency

2. Annex Participants

Canada:	Led by Dr. Mark Kozdras, CanmetMATERIALS, Canada (Co-Chair)
US:	Led by Dr. David Warren, Oak Ridge National Lab., USA (Co-Chair)
Germany:	Led by Ozlem Ozcan Sandikcioglu, BAM, Germany
Korea:	Coordinated by Dr. HW Lee, KERI, Korea

3. Activity

Incorporation of lighter materials such as aluminum, magnesium, and 3rd generation advanced high strength steels, polymers and carbon-fibre composites into vehicle structures allows designers to minimize structural weight through optimizing material selection component by component. Though the use of multi-materials structures has great opportunity for weight reduction, it poses new challenges with respect to mechanical and corrosion durability. As such, multi-material joining has been identified as a critical enabler to achieve reduced vehicle structural weight while maintaining safety and functionality. One US development project demonstrated a 9.1% reduction in fuel consumption for every 10% reduction in total vehicle mass. Many methods for joining these materials are in various stages of development but the range and depth of their applicability to different material pairs is not well understood.

This Annex is aimed at developing and disseminating to the automotive industry a qualitative and quantitative comparison of different joining methodologies to serve as guidance for developing vehicle systems. Using a multi-country, multi-organizational test program, at least 14 methods for joining dissimilar materials will be evaluated using up to two different test methods. To the extend applicable for each joining method, dissimilar material pairs consisting of wrought cast, prepreg and compression molded materials will be evaluated. Standard specimen size for all materials has been set up to facilitate joining experiments and standard materials, currently of interest to the automotive industry, have been identified. Specimen generation is now occurring. The performance analysis will include quasi-static, dynamic and fatigue performance after exposure to various environmental stressors. A comparative analysis for the performance of different methods will then be made available to the industry through topical reports and journal publications and an easy access database.

FINANCING

AMT is a task-shared Implementing Agreement. Every participant in each country receives funding from the government agencies, universities, and industries on specific Annex activities or related projects. AMT does not have a common fund.

EXECUTIVE COMMITTEE MEMBERS

Mr. Jerry Gibbs, Department of Energy, USA (Chair)
Dr. Stephen Hsu, George Washington University, USA (Vice Chair)
Dr. Ozlem Ozcan, BAM, Berlin, Germany (Secretary)
Dr. Mark Gee, National Physical Lab, UK
Dr. Mark Kozdras, CanmetMATERIALS Laboratory, Canada
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Dr. Junyan Zhang, Lanzhou Inst. of Chemical Physics, CAS, China
Dr. Lidong Chen, Shanghai Institute of Ceramics, CAS, China
Dr. Izhak Etsion, (Haytam Kasem alternate) Technion, Israel
Dr. Jae Seol Lee, Korea Inst. of Energy Technology Evaluation and Planning (KETEP)
Dr. Hee Woong Lee, Korea Electrotechnology Research Institute (KERI)

Pending ExCo members

Prof. Henara Costa, Universidade Federal do Rio Grande, Brazil
Prof. Friedrich Franek, ÖTG, Austria

CONTACT INFORMATION

Further details on AMT activities can be found on www.tcp-amt.org. For more information please contact Dr. Stephen Hsu at Stephen.hsu@erols.com

The current Secretary of IEA AMT is:

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