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Evaluation of LIST-MRT

Report by the external peer review committee

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Executive summary

This report presents the results of the peer review of the Department Materials Research and Technology (MRT) of the Luxembourg Institute of Science and Technology (LIST). The review covers the period 2014-2017 (with a focus on the period after 2015 when LIST was formed in a merger) and considers scientific and technological performance, relevance for society including client and partner interaction and the governance and organisation as requirement to sustain the ability and suitability for promoting both scientific performance and interaction with clients and partners.

The review was performed by an independent external assessment committee, consisting of five internationally renowned researchers in the field of the research of the Department, Prof.em. Louis Schlapbach (Chair, Switzerland), Prof. Renaud Bachelot (France), Prof. Bernd Mayer (Bremen), Prof. Xavier Obradors (Spain) and Prof. Stefaan De Wildeman (Belgium). Geert van der Veen and Katharina Warta (Technopolis Group) acted as support for the peer review committee.

The committee concludes that LIST-MRT developed very well, despite the challenging years of the evaluation period with moving targets with respect to the balance between research and innovation, especially over the last 2 years.

The mission of LIST-MRT including excellence in science and technology is considered appropriate, although referral to selected socio-economic challenges and the (societal) value added of LIST-MRT is missing. The use of TRLs is in the eyes of the review team inappropriate for scientific work. Formulation of the mission at LIST-MRT level creates tension with the focus of the LIST institute mission on TRL levels 3-7.

The research portfolio of LIST-MRT is well chosen, but more focus is needed to further strengthen the department. Overall, LIST-MRT can be qualified as a strong player on the international stage. Firm developments have been shown over the past years in e.g. scientific output at higher impact levels, number of patent applications and PhD training. The output quality and quantity differ however significantly between units.

LIST and LIST-MRT made good use of FNR support for the recruitment of talents. The gender balance leaves room for improvement.

Working conditions of scientists and technical staff are designed appropriate compared to international standards. The research infrastructure is considered as very good and, in parts even excellent.

The collaboration between LIST-MRT and University of Luxembourg (UL) was strengthened considerably. The collaboration with industry was very well developed in the past years; the big joint programme with Goodyear is a milestone. The contact with more flexible SMEs is more difficult, but has recently received an impulse in three CORE-PPP (Bridges) projects.

LIST-MRT functions under healthy and stable financial conditions. 5.7 M€/y from FNR (average 2015-17), EU revenues are going upwards from <50 k€ (2015) to >700 k€ (2017) and should further increase; LIST-MRT should compete again for an ERC grant. Income from cooperation with industry has increased sharply.

The business model for internal and external processes became not clear for this peer review committee and needs further attention at institute level. The internal administrative burden is considered significant by many of the staff interviewed and the overhead costs are high.

Impacts of LIST-MRT in the field of patenting, spin offs and tech-transfer have been increased significantly over the evaluation period. The policy is centrally coordinated at LIST level and should be reviewed in more detail at the institute level peer review.

The peer review committee has the following recommendations:

- Adapt the mission at LIST level: in order to fulfil its bridging role LIST-MRT (and LIST as a whole) needs strong anchors on both ends; generation of knowledge by scientific excellence and creative valorisation with impact on economy and society.
- Identify posteriorities to allow new activities: with structured processes posteriorities should be identified and phased out and spin-off actions initiated. Visionary leadership with clear ambitions related to mission, megatrends and opportunities should be strengthened. The installation of an International Advisory Board is recommended.
- Continue recruiting top talents using FNR funding (PEARL, ATTRACT, ...) and apply again for an ERC Grant. Recruit highly motivated ambitious leaders for transfer and valorisation. Special programs and communication activities dedicated to attract female scientists should be developed and implemented. An Alumni Organisation should be set up.
- Increase interaction with stakeholders on a European level.
- Strengthen leadership (unit leaders, group leaders) and promote entrepreneurial thinking.
- Further intensify the collaboration between LIST-MRT and UL.
- Strive for legal alignment of cooperation models by having legal templates for types of partnerships, and intensify presence in technical magazines for SME-readership, in order to strengthen cooperation with (esp. smaller) industry. More and stronger relations with industry outside Luxembourg and Grande Region should be considered.
- Care for a lean and flexible administration, at the level of LIST-MRT and the level of LIST.

Table of Contents

1	Introduction.....	1
1.1	Background.....	1
1.2	Composition of the Committee, independence, data provided, and procedures followed	1
1.2.1	Composition of the Committee	1
1.2.2	Independence.....	2
1.2.3	Data provided to the Committee	2
1.2.4	Procedures followed by the Committee.....	2
2	The positioning of LIST-MRT.....	4
2.1	LIST-MRT strategy and targets.....	4
2.2	LIST-MRT clients and stakeholders.....	4
3	Assessment of LIST-MRT	5
3.1	Research and technology quality: general development	5
3.2	Research and technology quality at unit level	6
3.2.1	Nanomaterials and nanotechnologies	6
3.2.2	Sustainable composite materials.....	6
3.2.3	Transversal programmes	7
3.3	Innovation quality and impacts	9
3.4	Collaboration and PhD formation, value for Luxembourg.....	9
3.5	Management and governance	10
3.5.1	Human Resource Management.....	10
3.5.2	Working conditions and infrastructure.....	11
3.5.3	Campus	11
3.5.4	Finance/Budget/Funding	11
3.5.5	Governance and post-merger development	12
4	Conclusions.....	13
5	Recommendations	15
	Appendix A Members of the Assessment Committee	16
	Appendix B Site visit programme.....	18

1 Introduction

1.1 Background

This report presents the results of the peer review of the Department of Materials Research and Technology (LIST-MRT) of the Luxembourg Institute of Science and Technology (LIST). LIST-MRT is built upon the materials R&T units “Science et Analyse des Matériaux (SAM)” and “Advanced Materials and Structures (AMS)” of the former CRPs Gabriel Lippman and Henri Tudor, respectively.

LIST (one of the 3 Luxembourg Institutes (LI) together with LIH and LISER, former Centres de Recherche Publics in Luxembourg) contributes to society by becoming a fully operational research and technology organization (RTO) anchored in Luxembourg, with a strong influence in Europe, positively impacting the country’s socio-economic development. LIST undertakes research, development and innovation activities in order to promote the generation and transfer of knowledge and technology and secure scientific and technological cooperation at national and international level.

The vision of LIST-MRT is to deliver industrial innovation through excellence in materials research and technology—with both local and global impact. LIST-MRT’s mission is to conduct leading-edge materials research and to integrate its successful materials developments into innovative products and processes, thus generating and transferring scientific knowledge and technical know-how from the lab to the industry. As a key catalyst, LIST-MRT aims to master enabling science and technologies for: (i) supporting the innovation roadmaps of Luxembourgish companies, including the attraction and promotion of talented scientists and engineers (ii) attracting high value-added companies in view of the country’s diversification strategy, and (iii) fostering the setting up of strategic directions of materials technology in Luxembourg and Europe. Within the above context of materials research and technology and based on the pre-merger analysis of strengths and opportunities, the LIST-MRT department has chosen two focus areas: (a) Nanomaterials and Nanotechnology, and (b) Polymer and Composite Materials.

The peer review is part of an evaluation of the three LI under the responsibility of the Luxembourg Ministry of Higher Education and Research (MESR). The evaluations cover the period 2014-2017 (with for LIST a focus on the period after the merger to form LIST, so 2015-2017) and consider scientific and technological performance, relevance for society including client and partner interaction and the governance and organisation as requirement to sustain the ability and suitability for promoting both scientific performance and interaction with clients. The evaluation has been assigned to Technopolis Group (www.technopolis-group.com).

The results of this peer review feed into the evaluation of LIST as an institute and into the evaluation of the three institutes at national level. For this reason, the chair of the LIST-MRT peer review also participates in the peer review of LIST at institutional level. The results are intended for MESR to (re)define their relation to the institute; for the institutes to help them to benchmark and improve their performance further and for other (mainly public)-stakeholders to use as they find suitable.

The peer review set-up has been designed by Technopolis Group, based on the Terms of reference from MESR. It aligns with good practices used in many evaluations.

1.2 Composition of the Committee, independence, data provided, and procedures followed

1.2.1 Composition of the Committee

The audit was performed by an independent external assessment committee, consisting of five internationally renowned researchers in the field of the research of the Department:

- **Louis Schlapbach** (Chair), Prof.em. ETH and Université de Fribourg, Experimental Physicist, Director Empa 2001-2009, Expert for FNR.

- **Renaud Bachelot**, Professor of physics at the University of Technology of Troyes (UTT), head of the Light, nanomaterials, nanotechnologies laboratory (L2n, former “LNIO”).
- **Bernd Mayer**, Professor for Polymeric Materials, Department of Production Engineering, University of Bremen and Director at the Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM, Bremen
- **Xavier Obradors**, Research Professor and Director of the Institute of Materials Science of Barcelona (ICMAB-CSIC).
- **Stefaan De Wildeman** has acquired a Professor position in New Building Blocks at Maastricht University, and recently started a technology company in Specialty Bioplastic Materials (B4Plastics).

Short CV’s from all assessment committee members are attached in Appendix A.

Geert van der Veen and **Katharina Warta** (Technopolis Group) acted as support for the peer review committee.

1.2.2 Independence

Any existing personal or professional relationships between committee members and programmes under review were reported and discussed in the committee meeting to safeguard an independent assessment of the quality of LIST-MRT and its research programmes in an unbiased and independent way. The Committee concluded that there were no close relations or dependencies and that there was no risk in terms of bias or undue influence.

1.2.3 Data provided to the Committee

In preparation of the review the peers received the following information:

- A self-assessment report of LIST at institute level.
- A self-assessment report of LIST-MRT at department level.
- A background report for the peer review of LIST prepared by Technopolis Group, including amongst others, an analysis of the participation of LIST in FNR and EC research projects and a bibliometric analysis of the publications of LIST (by ECOOM).

The assessment in combination with the discussions of the peer review committee with the research leaders, researchers and stakeholders allowed an objective evaluation of LIST-MRT.

1.2.4 Procedures followed by the Committee

The final assessments are based on the documentation provided by the Institute and the site visit to LIST-MRT in Luxembourg on 20-21 September 2018 (programme in Appendix B).

At the beginning of the site visit, the Committee was briefed by Robert Kerger of MESR and Geert van der Veen and Katharina Warta of Technopolis Group about the objectives of the evaluation in general and of the evaluation by the committee in particular. During this meeting, several questions were clarified. The Committee also agreed upon procedural matters and aspects of the assessment.

At the end of the site visit and interviews the Committee elaborated and discussed the conclusions and recommendations. Draft conclusions were presented to the participants in the discussions including the management of LIST-MRT and LIST, and representatives of MESR.

A first version of this report was drafted by the peers in the weeks after the site visit to Luxemburg. The report was finalised through email exchanges. The final version was presented to the Institute -October 2018. The reaction of LIST-MRT regarding factual points was demanded and then discussed by email by the Committee and led to adjustments of some factual points. The final report was then submitted to MESR.

Although direct comparison of LIST-MRT with other institutes in Europe is difficult, since the mission and environment of various institutes can be very different, the performance of LIST-MRT was

compared by the peer reviewers in a qualitative way with international state of the art. Publication and citation records were examined, major achievements were considered and the capacity to attract highly qualified students and collaborators was discussed. For obtaining a view of the relevance for science, elements such as recognition as a knowledge centre, participation in expert groups, editorial boards and professional societies were used. The relevance of LIST-MRT in relation to materials research and technology was judged at the international and local level. Services and expertise rendered to clients and partners and the impact on the general public served to assess the relevance for society.

Evaluation of governance and organisation of LIST-MRT was mainly based on the discussion about the strategy with LIST-MRT staff members. The findings related to the departmental organisation show adequate robustness. The findings related to the positioning of the department within LIST and the positioning of LIST in the research and education landscape in Luxembourg and in international perspective give the reflection of the peers on the vision of LIST-MRT but require further input from other stakeholders inside and outside LIST. Therefore, these findings are preliminary and have been fed into the evaluation of LIST at institute level.

2 The positioning of LIST-MRT

2.1 LIST-MRT strategy and targets

From Research over Development to Innovation (R&D&I) is a dynamic process. Especially small countries need a common mission and strategy for their higher education, research, development and innovation activities and institutions, in order to provide essential services for the country and attain critical mass to reach excellence. Application of research is only feasible after the generation of research results. Good researchers need the freedom to start new research themes, new results push creativity for applications and innovations, and when they are mature for the market a phase out process has to be initiated. The strongest innovation eco-systems are however shaped and effectuated when the creativity of these good researchers is anchored onto Innovation Champions, that link the technological advances to societal and economic themes and opportunities.

For LIST-MRT the mission given in the SAR “An internationally competitive research department fostering a culture that combines excellence with impact ... LIST-MRT’s mission is to conduct leading edge materials research and to integrate its successful material developments into innovative products and processes, thus transferring scientific knowledge and technical know-how from the laboratory to industry” is appropriate, although referral to selected socio-economic challenges and the value added of LIST-MRT is missing. This could be resolved by choosing and naming specific target fields (not too many, in order to achieve/maintain critical mass) where the excellence is pushed to impact, ideally supported by own example innovations in these fields from the past (track record supported).

This formulation of the mission at LIST-MRT level, creates tension with the focus of the LIST institute mission on TRL levels 3-7 because it leaves out lower TRL levels, highly important for knowledge creation. The Committee strongly supports a broader mission of LIST-MRT, which includes more the generation of knowledge: Despite having attention for application, keep up excellence in science. This is needed to attract talent by international visibility for science and business. Respecting each other, competences for collaboration and trust are more important than specifications by TRL levels. Also, RTOs regularly need to define priorities and posteriorities.

2.2 LIST-MRT clients and stakeholders

There are various external stakeholders of the LIST-MRT department: industrial companies, public organisations (national and European), scientific communities and organisations (incl. UL), suppliers and legislative bodies. Some of these stakeholders represent clients at the same time.

The peer review committee had a personal exchange with some representatives of industrial customers and partners. The general feedback has been very positive: they pointed out that co-operation with the LIST-MRT department is very trustful and productive; the scientific and technical expertise of LIST-MRT is considered as quite helpful to support the national industry base in Luxemburg.

SMEs with small or no own R&D unit need special attention as stakeholders and partners/clients. So, SME are logical co-operation partners for an RTO organization like LIST-MRT, for short term trouble shooting but also for medium to long term technology development. In 2017-2018 LIST-MRT started three CORE-PPP (Bridges) projects with this group of companies (Circuits Foils, i-Space & MetLux). This should be continued.

The number of EU funded collaborative projects has been increasing over the last years, but the total number of projects as well as the success rate of project proposals gives room for improvement – e.g. so far, no ERC grant has been obtained for LIST-MRT. In order to achieve this interaction with the stakeholders on a European level needs to be strengthened. *LIST-MRT needs to involve itself more into working groups of the EU to provide input to the design of future research programs and calls.* This will help at the same time to integrate LIST-MRT into European networks specifically focusing on certain industry segments.

3 Assessment of LIST-MRT

3.1 Research and technology quality: general development

The main portfolio consisting of the 2 research-development-innovation (RDI) units i) Nanomaterials and Nanotechnology, and ii) Sustainable Composite Materials builds on existing competences from the former SAM & AMS and is in line with EU recommendations for key enabling technologies. The portfolio is completed by iii) Transversal RDI units with platforms supplemented by transversal support function.

After the merger of the departments SAM and AMS of the Centres de Recherche Publics Gabriel Lippmann and Henri Tudor the LIST-MRT department developed research quality and quantity in a very positive way in several of its working units. Publications in high(er) impact journals resulted in more invited talks at relevant international conferences and Luxembourg's materials research and technology efforts gained international visibility. The number of patent applications increased from typically one per year prior to 2010 to an average of 15 per year in the period 2015-17. Several leading researchers became board members at international institutes (e.g. the Leibniz Institut für neue Materialien, the "Pole de competence MATERALIA", France).

LIST-MRT was very successful with FNR competitive funding (e.g. CORE Materials Research Calls), reasonably successful with EU-H2020 competitive funding and not yet successful with EU-ERC grant funding.

The FNR-PEARL grant for Jens Kreisel (moving from Minatec, Grenoble) was clearly a very important impetus for the field of multiferroics - part of the nanotechnology activities - in Luxembourg and also helped very much in the development of a true research culture at LIST-MRT. Cesar Garcia won an FNR-ATTRACT grant for work on promising new programmable diagnostic devices. Unfortunately, the work started in 2016 with the 2nd FNR-PEARL grant, entitled "Sustainable Multifunctional Polymeric and Composite Materials", with Philippe Dubois as Principal Investigator, was stopped in its early stage when he left for an even more attractive position abroad (Rector U-Mons).

The establishment of the National Composite Centre and the big PPP-Program of LIST with Goodyear demonstrate the progress and success of the technology competences of LIST as well, greatly enabled by LIST-MRT.

The research performance of the best LIST-MRT groups is very good on an international level.

Efforts to develop the culture for research and innovation with curiosity and ambitions to solve challenging problems produced impressive results; despite the difficulties of convincing staff with a pure service oriented background to contribute to creative own research.

The project portfolio and department income is significant for each unit and group and compares with other institutes in Europe.

The strategy in terms of domains of research is however not very clear: through 8 research groups (including two transversal ones) about 60 FTE (full time equivalent) of the category "Research & Technology Staff" with a PhD degree (RTS) are working on numerous and quite different subjects of research and techniques involving many kinds of topical materials and methods. Focus on most important topics is recommended. Groups are well dimensioned (8-25 persons/group, the biggest groups being in the Nano unit).

It seems that a bottom-up history (CRP Lippmann and Tudor) has been leading to the current LIST-MRT general performance that is good enough but could become outstanding by rationalizing and reorganizing in the near-future in order to extract more top-level topics like those introduced by the PEARL programme and the start of the nanotech-research. During the committee visit, the new department director expressed his wish to do so. The platforms, and related skills in instrumentation/technical methods are of good performance level and should be pushed further.

LIST-MRT research productivity is good, compared to similar European institutions, but not outstanding. The publication IF increased to 5-6. If LIST-MRT, taskforced by the RTO mission, could further improve its productivity - as is the tendency since 2015 - it could further gain differentiation on a European and even global level.

Furthermore, the number of patents filed by the Nano Unit has strongly increased. This situation reflects the balance between research and transfer of technology to industry and society in LIST-MRT. This is a remarkable development. As a result, LIST-MRT has been successful in building up strong partnership with industries of different sizes (from big companies, like Goodyear and Zeiss, to SMEs) allowing the department to envisage actual societal impact of the research in the frame of Key Enabling Technologies (KET) strategy. Concrete current examples are: better and safer car tires, smart car windows based on transparent electronics, optically tuneable nanomaterials for low-consumption air conditioning systems and sensing.

It is suggested that LIST-MRT sets clear targets for number and quality of publications and number and use of patents (e.g. number of patents licensed to partners) it wants to achieve, at the level of the international institutes it wants to measure itself against. For the next period success should be evaluated against these targets.

3.2 Research and technology quality at unit level

3.2.1 *Nanomaterials and nanotechnologies*

The nanomaterials and nanotechnologies unit at MRT-LIST has 55 staff (18 R&T associates, 8 post-docs, 26 PhD students, 3 technical experts). It produced over the period 2015-17 34 patents (related to an industrial cooperation portfolio of almost M€5) and 105 publications with an average IF of 5.7.

The unit consists of three research groups.

The research group FMT (Ferroic Materials for Transducers, looking at cooperative phenomena at nanoscale,) is respected by the international community; they show great potential for valorisation e.g. in sensing fields (optical or electronic or magnetic) and offer excellent opportunities for intense collaboration with UL and a sound basis for future spin-offs.

The research group “Nano-Enabled Medicine and Cosmetics” (NEMC) is operating in a well-chosen field, following very valuable contacts and contracts with cosmetic industry. The engineering activity for nanostructures is very competitive. The team is not yet an international player but reached partnership with cosmetic industry. In future, parallel development of both fields, cosmetics and nano-enabled bio-med-tech should be promoted; especially in sensing for health monitoring interesting opportunities seem present.

The research group “Transparent Electronics and Optically Tuneable Nanomaterials” (TEOTN) profits from synergies with the ferroic materials activities (and vice versa). On the science side the team successfully handled several FNR and self-funded (block grant) research projects, not yet reaching very high international level. However, impact for various innovative applications resulted in rich contacts with industry and following PPP.

Several further topics like e.g. Electrocaloric Materials (with a publication in Nature Communications 2018) were presented; they do not yet have high priority; as clearer focus is needed to intensify R&D on well justified themes, several themes should be abandoned.

3.2.2 *Sustainable composite materials*

The sustainable composite materials unit at LIST-MRT has 39 staff (18 R&T associates, 6 post-docs, 10 PhD students and 5 technical experts). It produced over the period 2015-17 103 publications with an average IF of 3.7 and only 1 patent. Recently it got a strong basis for a future impactful research and technology development quality by investments in:

1. **Human Resources:** strong and intrinsically motivated profiles were successfully attracted as principal investigators (PIs) in experimental and modelling fields with (i) increasing impact factors of peer-reviewed publications, with (ii) some H-indices reaching +20 and with (iii) publication citations throughout the careers sometimes exceeding 2000 (academic profile). The important position of LIST-MRT head of unit is however still open (the former PEARL funded head of unit left after 1 year),
2. **Equipment:** an up-to-date research infrastructure has been installed in a practical and integrated way, involving powerful analysis and processing equipment stretching over the whole value chain,
3. **Research fields:** The chosen research fields stretch over the value chain from synthesis of chemicals to synthesis of polymeric materials to prototyping and demonstration of new products. Combining “modelling” with “wet-chemical synthesis and processing” and with “application development in specific application fields via prototyping/testing” they have a strong synergetic potential.

On each of these lines, the following strategy elements can be considered to harvest the full potential of the unit.

Human Resources. After the successful installation of key-PI’s of the groups in the unit, it will be important to consolidate on them on the long term (5-10 years) to come to a mature harvest. Given the strong intrinsic motivation of several PI’s, LIST-MRT should sufficiently support them in their authenticity and autonomy, which could translate in their desire to link closely with universities, companies or with (self-generated) spin-offs/start-ups.

Equipment. With the very appropriate and multi-purpose equipment, there seems to be no bottleneck on the infrastructure present in the unit. If moving to another (united) LIST location in the future, the very valuable equipment and its output should be well planned, and the new destination should ideally be at current standards in terms of space, integration and high standards.

Research Fields. Over the last 10 years on a global scale, many initiatives in bio(based) composites and polymeric materials, have not brought the anticipated impact. It seems that, partially, the market needs a lot of time to mature, and surfs on hypes of over- and under-investment. Still, all indications in society show that this field will (have to) pick up to industrial standards. For LIST to be successful, it requires entrepreneurial competences from the PI’s, supported by visionary leadership of their directors, to sense the biomaterial waves in society via academic and company partners, and even via LIST’s own Open Days in direct contact with the Luxembourg and European citizens. That requires a selection of target fields, to focus on segments where the unit has the opportunity to become top-level in academic and innovation output. Triggers can be legislation, business hype or consumer request.

The portfolio should be selected carefully to choose the battles where the unit can become strongest, from its HR – equipment and historical track-record points of view. LIST-MRT should consider niche applications where they can be unique, such as high-temperature composites and recyclable composites. The instalment of a new head of unit with excellent visionary leadership to fill the present vacancy will be very important in that respect.

3.2.3 *Transversal programmes*

There are four LIST-MRT transversal programmes (TP), which are pretty different from each other: two platforms and two transversal research groups in charge of unique instruments and method.

The platforms

The Materials Characterization and Testing (MCTP) platform (22 staff) (that is efficiently supported by the research facility management service, 10 staff) gathers standard, technical expertise to provide tools for general characterization and materials testing.

“Characterization” is described with the key-words i) Molecular Analysis, ii) Structural Morphology & Topography Analysis, iii) Elemental and Isotopic Surface Analysis and is based on SEM/EDX and XRD instruments. Neither these key-words nor the mentioned standard equipment underline particular strengths of the platform, but it is needed as support for different groups.

The materials testing (mostly mechanical testing of metallic materials), fire testing and accelerated ageing are highly appreciated by some industrial partners, resulting in substantial income through sub-contracting (35% of the platform income). The platform however needs a renewal process. Fire testing of components is at the border line of LIST and spinning out should be considered.

The Composite Processing (CP) platform (7 staff), dedicated to polymer and structural composite processing and characterisation, is an efficient tool to make a success of the strategic Goodyear-LIST partnership. This platform is strongly connected to the “Sustainable Composite Materials” unit. This connection is natural, but the platform could improve LIST-MRT transversality in the near future.

Lab equipment realized within the PEARL project and clean rooms for nanofabrication are surprisingly not included in the transversal platforms (but are available for the research).

Access and use of large-scale facilities like Synchrotron Light Sources or Neutron Scattering – both highly relevant tools for modern materials science is available via the National Contact Point, but is rarely used.

The transversal research groups

The AINA group aims at developing, studying and using high level scientific instruments based on charged particle beams for nanoimaging and nano-analysis (SIMS systems). This valuable heritage from former CRP Gabriel Lippmann has been successfully reinforced. As a result, the 17-person group has got very good quantity and quality of publications (average IF=5, 15 publications per year), 7 patents and 13.1 M€ external income funded projects (period 2015-2017). It presents a long-term R&D success on an add-on high chemical & lateral resolution instrument, unique worldwide in a narrow field. The team is clearly reputed within the international SIMS community, as illustrated by the average of 8 invited talks/year. The world-class facilities (including home-made prototypes developed by the team) are unique and allow LIST-MRT to have many academic and private partners and clients. The strong collaboration with Zeiss, resulting in a spin-off to manufacture the miniaturised SIMS add-on instrument in Luxembourg, is an illustrating example. For the future, despite the “particle-matter interaction” activity, since AINA is a real international research group, it should also identify an ambitious scientific strategy that is not only related to SIMS advanced instrumentation, but also to new physical/chemical material properties to be discovered or study with the instrument: Instrumentation is important, but should not be an end in itself.

The 24-person Process Engineering and Prototyping (PEP) group aims at developing new functional materials through advanced processing and prototyping development. Their strategy is relevant, and the performance is very good, as illustrated by the listed publications (42), patents (8) and funded projects (income 10.7 M€), although number of publication/year/RTS member is < 2. The main research themes (Plasma Science & Technology and Thin Film Processing) are relevant and topical. Both organic and inorganic thin film deposition is possible, which makes the group potentially visible, but scientific originality and breakthroughs in the international competition framework do not appear clearly, although the Nanopolypulse technique is an outstanding technological achievement (patented) with the potential for lateral and 3D-structured deposits. Again, the use of the technique and instrumentation for own materials research studies should be encouraged. The collaboration with the recently created molecular plasma group spinoff in Luxembourg is appreciable.

Using the present experience in thin and organic materials to go into research on photovoltaics (hopefully in collaboration with the PV professorship at UL) could be a promising strategy (recent project submission at EU level).

Transversal RDIs and Platforms are clear assets for the LIST-MRT department and, to some extent, for LIST. In particular, they allow LIST-MRT staff to fill the gap between TRL levels 2-3 and 4-7, and to have long term strong interactions with partners and clients, involving joint publications. The upscaling/downscaling approach is also something remarkable.

The available types of equipment are numerous and various, and most equipment is quite new. Interaction of the TPs with both LIST-MRT units (and with ERIN) seems to be effective and efficient, but should be clarified in terms of respective association of publications and budget to the different involved groups and programs. For example, as far as joint publications are concerned, the “first author” rule (where, for determining KPI progress, an article is counted for the first author only) seems rather restrictive to the peer review committee to identify the real contribution of LIST-MRT members.

For handling broader transversal functions across LIST temporary project structures and/or competence units could be envisaged.

3.3 Innovation quality and impacts

The general research quality at LIST-MRT is a strong foundation to exploit and further generate substantial innovation impact. All nano/multiferroics R&D has reached a firm position at international level and offers great potential to be exploited in selected sensor and health care applications. Certainly, the ion beam SIMS and - to a lesser degree - other instrumental activities (e.g. plasma instrumentation) have created unique competences and further potential for innovation. The Composites Unit cannot yet profit from this longer-term track record, since it was strongly reoriented only in 2016.

It looks apparent that the plasma activities and the medicine/cosmetics groups can benefit from a more entrepreneurial spirit, involving risk taking and decision on focus areas, while linking them up with company or spin-off dynamics and entering inclusively decided new niches – especially at the borderline with other competences present at LIST in general. Accurate use of synergies may help to speed up innovations.

For increased impact, the collaboration with industry can be better structured, though (and because) a very strong growth and a milestone (Goodyear collaboration) have been reached in recent years.

3.4 Collaboration and PhD formation, value for Luxembourg

The education & formation of PhD students and their strong contribution to the R&D work is essential at LIST-MRT. To make this possible there are already a great number of researchers at LIST-MRT with the ADR, i.e. the qualification to act as supervisor for PhD students. Furthermore, a Doctoral programme with UL and LIST-MRT as main actors was installed in 2016. Now a growing percentage of LIST-MRT-PhD students is affiliated to the UL, while in the past almost all PhD students had affiliations with universities outside Luxembourg. In this way, the opportunity to attract talent for both partners is assured. With the increased number of PhD students, safeguarding quality of the PhD training has become even more important.

Up to now, most of the PhD students being recruited under the auspices of PPP programs remain in the area after their graduation, either in the same company or in others of a similar field (but the absolute number is still low). It is clear, therefore, that LIST-MRT has an impact on the industrial capabilities of the region. The best PhD students with a research ambition try to remain in the academia, wherever they can have appealing opportunities and so they can also enrich the staff of LIST or take up positions at UL. It is suggested, to set up an Alumni association which should keep an interesting professional network of all the people trained at LIST-MRT.

There are already several areas where the complementarity between LIST-MRT and the UL is recognized, and actions have been identified which facilitate the collaboration. A vision for Materials Research in Luxembourg is now part of the “Common Strategy Paper 2016-25” of UL, LIST, LIH and LISER. The 3.5 M€ FNR-PRIDE project “Materials for Sensors and Energy Harvesting” was launched jointly between UL and LIST-MRT. A number of researchers from LIST-MRT are also affiliated to UL. An initiative to share facilities among both institutions related to supercomputing seems to be in place. This is clearly an initiative of common interest and actually computer simulation activities appear as a kind of topic that it is recognized as a future priority within LIST-MRT. LIST has also access to the documentation/library net of UL. This kind of collaboration initiatives need further promotion.

The extremely positive development over the last few years of the Physics and Materials Science Department of UL offers a strong opportunity for LIST-MRT to strengthen and coordinate the collaboration and increase the international visibility. Whereas complementarity in Physics-related R&D and training is already quite strong, UL has only limited activities in chemistry. Many of LIST-MRTs activities (in polymers and composites, but also in e.g. in instrumentation plasmaphysics and nanosynthesis chemistry) clearly would profit from more basic work at UL.

LIST-MRT has an active network for international collaborations in research and PhD-training, visible in joint publications and common EU-projects. From the SAR it is not visible to which extent the network is used for stimulating exchange & mobility of employees (e.g. sabbaticals).

Internal-transversal collaboration among LIST Departments and units, even if some interesting initiatives have been identified (nano-safety for instance), needs further strengthening in the future. Incentives of such collaborations should be identified and established.

The strong links of LIST-MRT with industry are clearly an asset. A programme to keep contact with SMEs has been already implemented (and should be allowed to come to full maturity). Initiatives to attract large industries to the region should be supported. The strategic collaboration with Goodyear is an exceptionally good example, to be used as a showroom of success and prestige. The high quality of the existing equipment and infrastructure at LIST-MRT becomes a very powerful attraction for many industrial partners having some R&D activity. A limited number of successful start-up companies have been created as well. To a large extent, they can be identified with the most outstanding R&D topics where the groups at LIST-MRT had already an international competitiveness prior to the merger.

In conclusion, the activities developed at LIST-MRT have a strong impact in the Luxembourg region. This is a trend that should be intensified in the future more systematically in parallel with an enhanced international visibility. Particularly, clear KPIs appropriate for both areas – research for knowledge generation (science) and technology valorisation – should be identified to quantify the success in these areas in the future, and implemented.

3.5 Management and governance

3.5.1 Human Resource Management

LIST-MRT as a department and LIST as an institute have to be attractive for scientists, PhD candidates and technical/administrative functions on a national and international level. Since establishing LIST-MRT in 2015, the department has been quite successful in hiring high quality scientists. Few scientists have a local background in Luxemburg. Scientists mostly come from European countries like France. Engineering expertise remained more at status quo. The peer review team had a personnel exchange with selected postdocs and PhD students. The general feedback was very positive. PhD students and postdocs demonstrated high level of satisfaction with their scientific work, their supervision as well as with the infrastructure.

Up to now, LIST-MRT was in the position to fill open vacancies without major problems. With increasing mobility of master and PhD students, there might be more competition in the future – from a national as well as from an international perspective. At the moment, this holds for engineering sectors most prominently. LIST-MRT (or even better, LIST centrally) should develop means to address young scientists and students, directly communicating the vision and mission of the RTO, also with the goal to attract young female scientists (see below).

LIST does pursue three career lines for scientists (“Research & Technology”, “RDI Management” and “Partnership Development & Valorisation”) and relevant training programs are offered. The set-up looks logical and transparent; to what degree people follow these career lines and/or switch between the different career lines is not yet visible.

The ratio of employees with permanent (60% in 2017) and with non-permanent contracts sets is at a good level, providing job-security to most staff but allowing for flexibility.

The gender balance leaves room for improvement – a female part of just 22 % is fairly low, especially considering the high level of natural scientists. Specific mentoring programs and/or dedicated development activities for female scientists are not available at LIST. Special programs and PR activities dedicated to attracting female scientists should be developed and implemented.

The PhD training on MRT level is done quite well. There are several trainings offered by LIST and by the UL, for developing scientific as well as personal competences. Moreover, there is an established network of PhD students at LIST, which supports students as an interdisciplinary team.

There is no evidence that LIST-MRT offers training for senior experts in industry and society. For a proper dissemination of know-how this might be an additional field of activity to be considered.

There is also no evidence of a membership or support of EURAXESS by LIST-MRT. In more general terms, the networking on a European level could be extended. Exchange with other European research centers and organizations have not been a focus so far. This might be an important subject for the upcoming years. It will not only make LIST attractive for new scientists but will support the acquisition of collaborative programs on a European level. More generally, temporary exchange of employees with partner institutions and sabbatical leaves should be promoted.

3.5.2 Working conditions and infrastructure

Working conditions of scientists and technical staff are considered appropriate compared to international standards. The technical labs which were presented are spacious and demonstrate state of the art installations. Workers safety considerations are taken care of. The LIST-MRT department is located in three buildings being located several kilometres apart from each other; the SWOT analysis of LIST-MRT states this as a major weakness. Appreciating the hurdles for the internal communication in this scenario, this is still considered as being manageable.

Overall there is enough space for laboratories and offices at present: LIST should be creative to solve short-term working space restrictions, e.g. not all of the older instruments need to be kept in lab-space.

The research infrastructure that has been presented during the peer review is considered as very good and, in parts, even excellent. Substantial investment has been made to upgrade the technical infrastructure for the composite group. FNR offered financial support for the acquisition of expensive instruments. Analytical as well as processing equipment are on a very competitive level, on national and on international benchmark. Trained technical operators are available for each piece of equipment, which is supposed to ensure proper use of the scientific infrastructure.

Besides this, scientists have access to literature/library via the UL. There is a national research network established that shares access to scientific papers and patents. According to the LIST-MRT management this works without hurdles.

In total, the infrastructure and the working conditions are rated as good to excellent: international standards are matched, for sure.

3.5.3 Campus

Luxembourg is in an ongoing process to concentrate its activities in higher education (UL), Research-Development-Innovation (UL, Lis) and research funding (FNR) on the campus Belval around “La maison du savoir”. A main part of LIST is located in Belvaux, adjacent to the Belval campus, another part remained in Bascharage. LIST’s Belval Laboratories and many offices of LIST are located in the rather modern former Lippmann building, originally built as “provisorium”, however of quality to stand for 30 years (possibly not suitable for highest lateral resolution in microscopy due to vibrations).

3.5.4 Finance/Budget/Funding

LIST-MRT functions under healthy and stable financial conditions. The ratio of public funding (block grant) to collaborative funding with economy ascertains LISTs independence and provides opportunities for further growth: LIST-MRT is strong in constant acquisition of competitive funding by

FNR. EU funding is going upwards and should further increase. In line with high attention for excellence science LIST-MRT should compete again for an ERC grant. Income from cooperation with industry has increased sharply. This is capitalizing on long-term relations, made possible by the stronger RTO orientation.

The business model for internal and external processes needs further attention at institute level. How this works became not clear for this peer review committee at LIST-MRT level.

3.5.5 Governance and post-merger development

During this department evaluation it was noted that the directors of the departments are not members of the Board, and that thus their role for e.g. strategy development might be not be optimally used. The functioning of the Board is however an issue that will be addressed mostly at the peer review at institute level. In the opinion of the LIST-MRT peer review panel, the ensemble of the Board members needs high competences in all aspects of research, development, innovation, valorisation and communication. There seems room for improvement, including critically reviewing the Board nomination process.

The 4 years performance contract that LIST has with the Ministry is an efficient tool and, according to this peer review committee, appropriate KPIs are integrated. Internationally, the definition and handling of KPIs for R&D performance is quite accepted, in line with the continued focus on knowledge creation these should be maintained. For valorisation and impact however, strong disputes about suitable KPIs go on. After the period 2014-16, when there was a drive towards a focus on high TRL activity only, LIST-MRT strengthened its performance very considerably also with respect to the KPI.

The changing focus over the period 2014-16 between the extreme positions i) service oriented for national industry, ii) research quality leading to high international visibility, and iii) development work at high TRL, presented tough challenges asking for *too* rapid adaptation. Tudor-style traditional service culture is still present in a few units. The PEARL (FNR) enabled recruitment of Jens Kreisel and his promotion to LIST-MRT director resulted in an impressive development of research culture and growth of quality and intensity of research results **and** valorisation incl. start-up formation.

IPR management is mainly handled at the institute level and will be discussed during the institute level peer review.

4 Conclusions

General

The evaluation period covers four challenging years, with moving targets with respect to the balance between research and innovation (focus in TRL level 3-7). Despite this, LIST-MRT developed very well, especially over the last 2 years and followed the performance contract.

Mission/Vision

The mission of LIST-MRT given in the SAR “An internationally competitive research department fostering a culture that combines excellence with impact ...LIST-MRT’s mission is to conduct leading edge materials research and to integrate its successful material developments into innovative products and processes, thus transferring scientific knowledge and technical know-how from the laboratory to industry” is appropriate, although referral to selected socio-economic challenges and the (societal) value added of LIST-MRT is missing.

This formulation of the mission at LIST-MRT level, creates tension with the focus of the LIST institute mission limited to TRL levels 3-7 because it leaves out knowledge creation. The use of TRLs is inappropriate for scientific work. The Committee strongly supports a broader mission of LIST-MRT, which includes more the generation of knowledge: Despite having attention for application, keep up excellence in science.

Portfolio & Strategy

In view of the competences available at the time of the merger, their expansion with the PEARL project and the set-up of the Nano-unit, respecting the EU recommendations for key enabling technologies, and the opportunities for collaborative work with Luxembourg industries, the research portfolio of LIST-MRT is well chosen. It consists of the two research-development-innovation (RDI) units i) Nanomaterials and Nanotechnology, and ii) Sustainable Composite Materials. The portfolio is completed by the Transversal RDI groups and platforms supplemented by transversal support functions.

More focus is needed to further strengthen the department.

R&D&I quality and quantity

Overall, LIST-MRT can be qualified as a strong player on the international stage. Strong developments have been shown over the past years in e.g. scientific output at higher impact levels, PhD training and number of patent applications. The output quality and quantity differ however significantly between units.

On the research side the RDI unit Nano reached international top level with the topic multiferroics and the long-term Ionbeam-SIMS method and instrument development with market entry and start-up is unique (in a rather narrow field of surface analytical techniques). Some of the activities in composites have been installed only recently, but have considerable growth potential to international level. Plasma surface engineering and related activities got a new focus (medicine and cosmetics) based on industry collaboration, with high future potential when readiness for risk taking and new niches is available. A transversal activity with nano & sensing in view of small health monitoring devices should be considered.

Human Resources

LIST and LIST-MRT made good use of FNR support (PEARL, ATTRACT, ...) for the recruitment of talents, particularly on the research side. Crucial for achieving a full RTO portfolio is the recruitment of highly motivated ambitious leaders for transfer and valorisation. Leadership should be strengthened (unit leaders, group leaders) and entrepreneurial thinking promoted.

The gender balance leaves room for improvement – a female part of just 22 % is fairly low. Special programs and PR activities dedicated to attract female scientists should be developed and implemented.

Equipment, Infrastructure

The concentration of Luxembourg institutions for higher education, research, technology and innovation in Belval progresses rather rapidly, though LIST is concerned by significant construction delays. Overall there is enough laboratory and office space at present. The location in three buildings being located several kilometres apart from each other may hinder internal but should be manageable.

Working conditions of scientists and technical staff are appropriate compared to international standards. The technical labs are spacious and demonstrate state of the art installations. The research infrastructure is considered as very good and, in parts, even excellent. Substantial investment has been made to upgrade the technical infrastructure for the composite group. Analytical as well as processing equipment is on a very competitive level, on national and on international benchmark.

Collaborations

Strong collaboration is built upon synergies and mutual respect. With its goal to connect science and market, LIST therefore needs to be respected by Academia, and especially UL. The collaboration between LIST-MRT and UL was strengthened considerably by appropriate tools over the evaluation period and should be further increased. The good relationship with new vice-rector for research is an excellent opportunity.

The collaboration with industry was very well developed in the past years; the big joint programme with Goodyear is a milestone. The contact with more flexible SMEs is more difficult, LIST developed valuable tools (a legal alignment of cooperation models should be added by having legal templates for types of partnerships), but might intensify its presence in technical magazines for SME-readership.

More relations with industry outside Luxemburg should be considered.

Finance/Budget/Administration

LIST-MRT functions under healthy and stable financial conditions. The ratio of public funding (block grant) to collaborative funding with economy ascertains LISTs independence and provides opportunities for further growth: LIST-MRT is strong in constant acquisition of competitive funding by FNR. EU funding is going upwards and should further increase: LIST-MRT should compete again for an ERC grant. Income from cooperation with industry has increased sharply. This is capitalizing on long-term relations, made possible by stronger RTO orientation.

The business model for internal and external processes needs further attention at institute level. How this works became not clear for this peer review committee.

The internal administrative burden is considered significant by many of the staff interviewed and the overhead costs are high. LIST should strive for leaner and flexible administration and administrative processes.

Dissemination, Valorisation, Communication

The Committee appreciates the increased quality and impact of scientific and technical publications, including the Nature Materials article on materials in Luxemburg of March 2014 and some good outreach activities like Open Days. Communication to possible outside users (new clients) should be increased, e.g. by targeting more also professional journals.

There is room for more inspirational communication to the Luxemburg public. The communication should better reflect the thoughts and ambitions of LIST on how the new economy will look like tomorrow (“tomorrow” as tag in LIST’s vision/mission statement).

Impacts of LIST-MRT in the field of patenting, spin offs and tech-transfer have been increased significantly over the evaluation period. The policy is centrally coordinated at LIST level and should be reviewed in more detail at the institute level peer review.

5 Recommendations

- The peer review Committee suggests adaptation of the mission at LIST level: LIST-MRT needs for its bridging role strong anchors on both ends; generation of knowledge by scientific excellence and creative valorisation with impact on economy and society.
- More focus is needed to further strengthen the department. With structured processes posteriorities should be identified and phased out and spin-off actions initiated to allow new activities. Visionary leadership with clear ambitions related to mission, megatrends and opportunities should be strengthened. The installation of an International Advisory Board is recommended.

Suggestions of the peer review Committee to assess for new activities are:

- sensor techniques based on nano-electronics, -optics or -photonics e.g. for health monitoring;
 - composites for bio-med-tech use;
 - composites for higher temperatures (300-350°C aircraft engine parts);
 - composites with higher UV-resistivity or better recyclability;
 - additive manufacturing.
- Leadership should be strengthened (Heads of unit, group leaders) and entrepreneurial thinking promoted. Staff should be trained to show more enthusiasm and ‘fire for R&D&I’ and to put more weight on output and impact than on input. The more passive behaviour (“what does industry need from us?”) should be shifted to a balance with active reason of existence like “what can we give industry and society”, and, “should this then be initiated by our own spin-off?”.
 - Continue recruiting top talents using FNR funding (PEARL, ATTRACT...) and apply again for an ERC Grant. Crucial for achieving a full RTO portfolio is the recruitment of highly motivated ambitious leaders both for excellent research and for transfer and valorisation. Special programs and PR activities dedicated to attract female scientists should be developed and implemented. An Alumni Organisation should be set up.
 - The number of European collaborative projects as well as the success rate of project proposals show room for improvement. Therefore, interaction with stakeholders on a European level needs to be increased. LIST-MRT should involve itself into working groups of the EU to provide input to the design of future research programs and calls.
 - Use and access to large scale facilities (Synchrotron Light and Neutron Sources) should be promoted. Replacement of equipment in the long run should be related to the long-term strategy. FNR could be better used to purchase new equipment/ infrastructure.
 - The collaboration between LIST-MRT and UL should be further increased, e.g. more PhD students affiliated with UL, joint seminars and colloquia, joint sport events.
 - In order to strengthen cooperation with (esp. smaller) industry, LIST should strive for legal alignment of cooperation models and intensify its presence in technical reviews for SME-readership. More and stronger relations with industry outside Luxemburg should be considered.
 - KPIs for innovation and valorisation (further than number of patents) need to be developed, implemented and communicated.
 - Care for a lean and flexible administration, at the level of LIST-MRT and the level LIST.

Appendix A Members of the Assessment Committee



Prof **Louis Schlapbach** (Switzerland) is Prof.em. Physics of ETH Zurich and former professor at the Université de Fribourg. As Director of Empa (2001-2009), a Materials Science and Technology Institution of the ETH Domain with 800 co-workers in Dübendorf-Zurich, St. Gallen and Thun, he successfully transformed the former materials testing institution into a modern materials research and technology laboratory. His research interests mainly concern nanoscopic properties of new materials and their surfaces/interfaces, hydrogen interaction with solids, and more generally materials for energy technology, with a focus on use inspired research. His NATURE-paper “Hydrogen-storage materials for mobile applications” (414, p. 353, 2001) was cited more than 5000 times, and the Springer books “Hydrogen in Intermetallic Compounds I, II” were quickly sold out. The Web of Science yields 380 publications with an average citations >30 and an h-Index >55. Louis Schlapbach was Member of the Research Council of the Swiss National Science Foundation SNF from 1997 to 2004; from 2009-2015 he presided the National Research Programme „Smart Materials“. From 2010-2016 he was Member of the Helmholtz Senat (Germany) from 2009-2018 he worked for the National Institute for Materials Science (NIMS), Tsukuba (Japan), as a part time scientist and as International Advisor of their WPI nanoscience programme MANA.

He works as an expert of the Swiss Innovation Promotion Agency Innosuisse as well as for various international research promoting and evaluating agencies like the Agence Nationale de la Recherche ANR (France), the Fond National de la Recherche FNR Luxembourg, Cariplo (Lombardia, Italy), Technopolis (UK), and Interface (Switzerland). He is Honorary Member of the Swiss Physical Society and Member of the Swiss Academy for Technical Sciences.



Prof **Renaud Bachelot** (France) is a full professor of physics at the University of Technology of Troyes (UTT) that he joined in 1996 after graduate studies and PhD at the University of Paris 7 and ESPCI graduate school (Paris). His area of expertise includes nano-optics, near-field optics, local light/polymer interaction, scanning probe microscopy, nano-optoelectronics and nanoplasmonics. At UTT, RB is the head of the Light, nanomaterials, nanotechnologies laboratory (L2n, former “LNIO”) involving more than 100 people (lnio.utt.fr). His national and international influence lies on several activities such as (e. g.) board member of the physics department of Sorbonne University (Paris); fellowship in Argonne National Laboratory (ANL) as an invited scholar, elected representative of the user executive committee of ANL Centre for Nanoscale Materials, and a Tan Chin Tuan fellowship at Nanyang Technological University (Singapore). RB has been the supervisor of 22 PhD students and is the co-author of more than 130 peer-reviewed articles, 10 book chapters and 5 patents.



Prof **Bernd Mayer** (Germany) is since 2010 director of the Fraunhofer Institute for Manufacturing Technology and Advanced Materials (IFAM) in Bremen, focused on Adhesive Bonding Technology and Surfaces and professor for Polymeric Materials at the Department of Production Engineering of the University of Bremen. He holds a PhD in inorganic chemistry from the University of Karlsruhe and was postdoc at the University of Pennsylvania in Philadelphia (USA). For almost 20 years he worked for Henkel A.G. where he was senior scientist in corporate research and head of product development Automotive Adhesives in Europe.



Prof **Xavier Obradors** (Spain) is a Research Professor and Director of the Institute of Materials Science of Barcelona (ICMAB-CSIC). His scientific interests include materials preparation with controlled micro/nano structures and the comprehension of the physical mechanisms underlying the superconducting, magnetic and electronic properties of nanostructured materials, particularly complex oxides. He has published more than 500 articles (> 10.700 citations, h=49), he has filed more than 12 patents and he was one of the creators of the spin-off company OXOLUTIA. He has been Principal Scientist of 13 National projects and 20 EU projects and he has coordinated 3 EU projects, among them EUROTAPES, the largest European consortium devoted to superconductivity up to now. He has received several awards: Fellow of Institute of Physics; Doctor Honoris Causa University of Pitesti; ENDESA Novare and National Materials Science Awards; Member of Academy of Sciences and Arts of Barcelona; Narcís Monturiol Medal of Catalonia; French Academic Palms; City of Barcelona Prize. He served in the Editorial Board of Superconductor Science and Technology and he is Editor of Physica C. He was President of the European Society of Applied Superconductivity. He has supervised or co-supervised 25 PhDs and he has given around 100 Plenary and Invited Conferences around the world. He has served in many scientific evaluation committees in Catalonia, Spain, France, Flanders, Germany, Portugal, United Kingdom, Luxemburg and Switzerland.



Prof **Stefaan De Wildeman** graduated as a Chemical Engineer in Applied Biological Sciences (KULeuven, 1998), and finished his Ph.D. after discovering a new bacterial species dehalorespiring chlorinated organic pollutants in groundwater (Ghent University / Friedrich-Schiller University Jena, 2002). In 2002, he joined DSM as an Associate Scientist in the field of Biocatalysis, one of DSM's world-leading competences. As a Senior Scientist, he has increasingly explored new options to link renewable raw materials to new biobased building blocks for novel materials with added functionality. Since 2013, Stefaan started up research activities, education programs and strategic projects on new biobased building blocks at Maastricht University and Ghent University. His hunger for social impact guided him to B4Plastics – a young start-up company that has the mission to “*make ecological plastic consumption easier*”. By *designing* novel plastic products for their eco-balanced application from scratch, the company offers plastic products with outcompeting eco-profile at acceptable cost. In 2017, under his guidance, B4Plastics became the first company in the world that released a smartphone-app supported plastic product (COMPOST3D®), thereby stimulating the eco-awareness of its users beyond the current state-of-the-art. In 2018, he took the dedicated role of managing director at B4Plastics to further expand the specialty bioplastics product portfolio.

Appendix B Site visit programme

19 September 2018

Time	Programme	With
late afternoon	Arrival of peers in Luxemburg	
19:00 - 22:00	Get together of the panel (over dinner), inform peers about peer review goals and approach	peers, MESR, Technopolis (TP)

20 September 2018

Time	Programme	With
08:45 - 9:00	Transfer to institute	
9:00 - 11:15	Short introduction to the institute, the department (and critical self-assessment of the department); discussion	Damien Lenoble, Jens Kreisel, Fernand Reinig, Christelle Vergnat
11.15 - 12.30	Tour around the department	Belvaux: Damien Lenoble, Marc Angotti, Patrick Choquet, Tom Wirtz, Sivashankar Krishnamoorthy, Emmanuel Defay, Nathalie Valle, Nicolas Boscher, Francois Neuilly Bascharage: Jean di Martino, David Ruch, Henri Perrin, Salim Belouettar, Daniel Schmidt, Pierre Verge.
12:30 - 13:30	(Simple) Lunch	Damien Lenoble, Jens Kreisel
13:30 - 15.15	Presentation and discussion on Nanomaterials & Nanotechnologies	Damien Lenoble, Renaud Leturcq, Emmanuel Defay, Jorge Iniguez, Sivashankar Krishnamoorthy, Cesar Pascual Garcia.
15.15 - 15.30	Tea/coffee	
15.30 - 17.15	Presentation and discussion on Sustainable Composite Materials	Damien Lenoble, David Ruch, Frédéric Addiego Salim Belouettar, Gaetano Giunta, Daniel Schmidt, Pierre Verge, Henri Perrin
17:30 - 18:30	Informal group meeting with junior staff	Lauriane Chuzeville (Nano), Mariapaola Staropoli (Nano), Acerina Trejo Machin (COMPO), Damian Aranda Iglesias (COMPO), Dominique Abessolo (PEP), François Loyer (PEP), Alisa Pshenova (AINA), Dana El Assad (MCTP)
18.30 - 19.00	Draft conclusion on the first day	PR+TP only
19.00 - 20:00	Transfer to hotel, Free time	PR+TP only
20:00	Dinner	with LIST-MRT staff

21 September

Time	Programme	With
08:30 - 8:45	Transfer to institute	
08:45 - 10:30	Presentation and discussion on Transversal Activities	Patrick Choquet, Nicolas Boscher, Tom Wirtz, Marc Angotti, Jean-Nicolas Audinot, Nathalie Valle, François Neuilly
10.30 - 10.45	Tea/Coffee	
10:45 - 11.45	Time scheduled for meeting clients/partners of the department	Nicolas Caillet (Arcelormittal S.A.), Willy Wintgens (Euro-composites S.A.), Thomas Devahif (Circuit Foil Luxembourg S.A.R.L.), George Thielen (Goodyear S.A.), Ralph Useldinger (Ceratizit S.A.), Alex Combe (Rotarex S.A.), Michele Luppi (Met-Lux S.A.), Christophe Delas (International Lacquers S.A.).
11.45 - 12.15	Time reserved for clarification questions	Damien Lenoble, Salim Belouettar, Tom Wirtz, Marc Angotti

Time	Programme	With
12:15 - 13:15	(simple) Lunch	PR+TG only
13:15 - 14:45	Time to draft preliminary conclusions	PR+TG only
14:45 - 15:00	Tea/coffee	
15.00 - 16.00	Presentation of preliminary conclusions	
16:00	End of programme, transfer to train station/airport	

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