MSc Biobased Materials

(wo-master)

Maastricht University

15 June 2015

NVAO Limited Initial Accreditation Procedure Panel Report

1 Executive Summary

The master programme Biobased Materials is offered by the Faculty of Humanities and Sciences of Maastricht University on the premises of the Brightlands Chemelot Campus in Sittard-Geleen, the Netherlands.

Standard 1. Intended learning outcomes
The master programme Biobased Materials aims to deliver graduates who are able to participate in the development and production of materials from biological renewable feedstock with new and advanced properties for various kinds of applications. The intended learning outcomes of the programme include the necessary knowledge, competences and skills in the fields of biology, chemistry, materials science and application, the competences and skills to work in a multidisciplinary research environment and to contribute in a creative, innovative and responsible way to the production and application of biobased materials. The relevance of the subject and the multidisciplinary approach lead to an ambitious programme. The panel advises to include an explicit reference to the importance and implementation of green chemistry and green engineering in the intended learning outcomes.

The panel concludes that the intended learning outcomes of the programme meet the international requirements of comparable programmes. They are clearly described, linked to the Dublin descriptors and appropriate for an academic master programme. They also meet the requirements set by the professional field, as represented by the partner institutions at the Brightlands Chemelot Campus.

The panel assesses standard 1 'Intended learning outcomes' as satisfactory.

Standard 2. Teaching-learning environment
The panel has studied the curriculum and course descriptions and concludes that the structure of the curriculum is well thought out and that the contents enable the student to achieve the intended learning outcomes. The mandatory core courses provide a basis in the relevant domains, while the elective courses and projects allow for flexibility and enable the students to define their own profile. The programme thus strikes an important balance between educating generalists and specialists. A personal coach helps the students to make their choices. The course contents are still partially under development, but, based on the explanation provided by the programme staff, the panel is confident that they will fit the intended learning outcomes and be ready at the start of the programme. The didactic approach of Problem Based Learning (PBL) stimulates students to develop into independent and critical researchers with an open eye to practical and ethical issues. The link with academic research has been established, but should be further strengthened to ensure the contents, relevance and success of the programme. The companies at the Campus appreciate that academia can connect directly to industry through the recently established research group Biobased Materials. The admission criteria and procedures are clear and in line with the aim of the programme. The panel advises the programme to closely monitor the progress of the students and to organise a mid-term review after graduation of the first two cohorts in order to fine-tune the programme and admission criteria, if necessary.

The programme can draw on capable and enthusiastic staff members, bringing relevant networks with them. A few part-time professors have been hired and relationships with other universities and research organisations have been established. This has obviously

strengthened the knowledge base of the programme. For the sustainability of the programme, it is essential to continue these efforts, to further invest in full professors and to ensure a healthy balance between research and teaching for each staff member, including the programme management.

The facilities of the Brightland Chemelot Campus are currently sufficient and are expected to further improve when the new Center Court building will be available from September 2016. A strong point is the closeness of relevant industrial companies that will in various ways contribute to the programme. The combination of staff, students, research, industry and the location leads to an international and interesting setting for the programme. Nevertheless, the committee still has some doubt as to whether the programme will be able to attract the intended number of qualified students, as the campus is far from Maastricht, i.e. the students have to commute. The bus service provided for the BSc students will certainly be helpful for the MSc students as well.

The panel concludes that the curriculum, staff and programme-specific facilities constitute a coherent, attractive and innovative teaching-learning environment for the students. This enables the students to achieve the intended learning outcomes.

The panel assesses standard 2 ‘Teaching-learning environment’ as satisfactory.

Standard 3. Assessment
The panel has checked the Education and Examination Regulations 2015-2016, and found these to be in order. The panel has seen a draft of the master thesis guidelines. It is important that these will be finalised and available before the start of the programme. The panel has studied the assessment system and met with the examination board during the site visit. The panel concludes that the examination board is independent and well aware of its responsibilities, and has developed effective procedures to be in control of the quality of assessment of the programme.

The panel assesses standard 3 ‘Assessment’ as satisfactory.

Standard 4. Graduation guarantee and financial provisions
The panel has ascertained from the information dossier and the interviews during the site visit that Maastricht University and a combination of public and private organisations have significantly invested in the master programme Biobased Materials and that Maastricht University will guarantee sufficient financial provisions in the case of start-up losses. The panel is, therefore, convinced of the viability of the programme.

The panel assesses standard 4 ‘Graduation guarantee and financial provisions’ as satisfactory.

Given these considerations, the panel advises NVAO to take a positive decision regarding the quality of the new master programme Biobased Materials offered by Maastricht University.

Maastricht University proposes that the master programme Biobased Materials has a duration of two years (120 EC). The programme management’s arguments regard the international requirements of the programme, based on a comparison of similar programmes internationally, and the level of complexity of the programme, reflecting the requirements of the multidisciplinary domain of biobased materials. The panel is convinced that the qualifications the graduates should have in order for them to be competitive in the international academic job

market, cannot be achieved in a programme of less than two years. The panel, therefore, advises to grant the programme the right to offer a two-year master's programme (120 EC).

The panel confirms the allocation of sector as suggested by the applicant: Nature.

The Hague, 15 June 2015[1]

Prof. dr. Han de Winde
(chair)

Dr. Marianne van der Weiden
(secretary)

[1] De instelling heeft geen feitelijke onjuistheden vastgesteld in het ontwerpadvies van 8 juni 2015, zoals bevestigd per e-mail van 15 juni 2015.

2 Procedure

2.1 Process

Macro-efficiency	19 December 2014
Application	23 January 2015
Composition panel	9 March 2015
Site visit	30 April & 1 May 2015 (Sittard-Geleen and Maastricht)
Panel report	15 June 2015

2.2 Panel

Composition of the panel:

1. Prof. dr. Han de Winde, Professor of Industrial Biotechnology and Vice-Dean at the Faculty of Science, Leiden University (*chair*);
2. Prof. dr. Bert Müller, Thomas Straumann-Professor of Material Sciences in Medicine, Head of the Biomaterials Science Center, University of Basel, Switzerland;
3. Prof. dr. Alexander Bismarck, Professor of Polymer Materials, Department of Chemical Engineering, Imperial College London, UK and Professor of Materials Chemistry, Faculty of Chemistry, University of Vienna, Austria;
4. Drs. Renée Verhoeven, PhD student Department of Surgery, Liver Transplantation, Erasmus Medical Center Rotterdam (*student member*).

Assisting staff:

- Dr. Marianne van der Weiden, secretary to the panel;
- Michèle Wera MA, policy advisor NVAO and process coordinator.

2.3 Assessment framework

The framework for limited assessments of new programmes (2014, Nr. 36791) is used for institutions that have obtained a positive judgement following an institutional audit.[2] The assessment is based on a discussion with peers regarding the content and quality of the programme. It focuses on five questions:

1. What is the programme aiming for?
2. How does the programme intend to achieve its objectives?
3. How does the programme intend to assess its performance?
4. If applicable, are the objectives achieved?[3]
5. Does the programme have sufficient financial resources?

These five questions have been translated into five standards. Regarding each of these standards, an assessment panel gives a substantiated judgement on a three-point scale: meets, does not meet or partially meets the standard. The panel subsequently gives a substantiated final conclusion regarding the quality of the programme, also on a three-point scale: positive, negative or conditionally positive.

To assess the two-year duration (120 EC) of the programme, the panel used the NVAO Protocol cursusduur masters (8 October 2003).

[2] Institutions with a positive institutional audit may also opt for the framework relating to extensive initial accreditations.

[3] If the programme has already produced graduates, the panel assesses the achieved learning outcomes.

3 Programme

3.1 Administrative data

Country	The Netherlands
Institution	Maastricht University (positive NVAO decision institutional quality assurance assessment: 15 May 2013 until 15 May 2019)
Programme	Biobased Materials
Level	master
Orientation	academic (wo[4])
Credits	120 EC
Location	Brightlands Chemelot Campus, Sittard-Geleen
Mode of study	full-time
Field of study	Nature (as confirmed by the panel)

3.2 University

Maastricht University (UM) was founded in 1976 and stands out for its innovative approach to learning (Problem-Based Learning) and international outlook (47 per cent international students). With almost 16,000 students and 4,000 staff, UM offers seventeen academic bachelor and fifty academic master programmes. The university is organised in six faculties: Arts and Social Sciences, Business and Economics, Health, Medicine and Life Sciences, Humanities and Sciences, Law and Psychology and Neuroscience.

3.3 Programme

The master programme Biobased Materials is a multidisciplinary programme, integrating the relevant disciplines (molecular biology, chemistry, materials science and engineering) to cover the biobased material development chain from biomass up to the applied biobased material. Within the Netherlands, this is the first programme to focus exclusively on biobased materials and to approach this scientific topic from several relevant angles. The programme is a two-year (120 EC) fulltime programme, to be conducted in English, and intends to start in September 2015 with a first intake of fifteen students. The programme will be offered by the Faculty of Humanities and Sciences on the Brightlands Chemelot Campus, Sittard-Geleen. This location will facilitate the strong involvement of industry and research institutions.

[4] wo = wetenschappelijk onderwijs

4 Assessment

4.1 Standard 1 – Intended learning outcomes

The intended learning outcomes of the programme have been concretised with regard to content, level and orientation; they meet international requirements.

Findings
The master programme Biobased Materials aims to deliver graduates who are able to participate in the development and production of materials from biological renewable feedstock with new and advanced properties for a variety of applications.

The information dossier lists the following domain-specific learning goals:
'Upon graduation the students
1. have gathered extensive knowledge, competences and skills in identification, isolation, production, processing and application of biobased materials;
2. can apply gathered scientific knowledge, competences and skills to solve complex and relevant problems in the field of biobased materials;
3. are able to comprehend new emerging concepts, theories and techniques and use these to initiate creative research for solving relevant problems in the field of biobased materials;
4. can apply relevant skills and techniques to evaluate structure-function relationships of materials and assess their potential application;
5. can work in a multidisciplinary research group and give a significant and/or leading contribution to the scientific work within such a group;
6. are able to independently propose and/or execute research projects on biobased materials, analyse and interpret the results, and report to different groups of interest ranging from fellow scientists, to industrial management, policy makers and the general public;
7. are capable to communicate and create links with and between scientists and experts involved in the development, application and commercialisation of biobased materials;
8. demonstrate a creative and innovative attitude in their work that is driven by scientific curiosity and life-long learning;
9. are aware of the impact and effects of biobased materials and their production on human society and the environment they live in;
10. have developed into responsible and ethical scientists, who show social responsibility in the transition towards a biobased and sustainable society.'

In the information dossier these intended learning outcomes have been explicitly linked to the Dublin descriptors for a master programme. In addition, they have been more specifically defined in specific expertise, organised according to the chain of biobased materials development and the main scientific fields involved: biology, chemistry, materials science and the application of biobased materials. The panel appreciates this specification: it clarifies the aims of the programme.

The panel notes that the learning goals of the programme are ambitious and that the programme wants to contribute to the sustainability of our society. In that respect, the panel would have expected an explicit intended learning outcome related to the importance and implementation of green chemistry and green engineering in building a sustainable future.

The programme aims to strike a balance between educating generalists versus specialists. Through the combination of compulsory and elective courses, the students will be trained to oversee an important part of biobased materials and be encouraged to select a profile within the broad field. To support their specialisation, they will be stimulated to select courses from at least two domains (biology, chemistry, materials science and application). As a result, they will have a specialisation, without losing sight of the general field, and while being able to communicate with colleagues in the adjacent fields.

The panel had an inspiring and fruitful meeting with a number of representatives from industry. It became clear that the aims of the programme fit the needs of this part of the labour market and that especially the multidisciplinary approach and the emphasis on soft skills, e.g. in communication, are seen as strong points of the programme. The companies on the Brightlands Chemelot Campus will translate their interest and commitment into concrete contributions to the programme, such as staff input, lab facilities and project proposals. They view the master Biobased Materials as a joint venture, part of their long-term strategy. While academic contacts were not or less important in the past, they are crucial now. Opportunities can be found in pre-competitive academic research and in bilateral collaboration with universities on a higher confidentiality level. The programme fits well within the regional development of Limburg and the Euregio, the social and economic issues of sustainability and their inclusion in the 'Topsectoren' policy of the Dutch government and European research frameworks such as Horizon 2020.

Considerations
The panel has studied and discussed the aims of the programme and notes that the relevance of the subject and the multidisciplinary approach lead to an ambitious programme that is expected to be attractive for students and useful for the regional economic development. The panel advises to include an explicit reference to the importance and implementation of green chemistry and green engineering in the intended learning outcomes.

The panel concludes that the intended learning outcomes of the programme meet the international requirements of comparable programmes. They are clearly described, linked to the Dublin descriptors and appropriate for an academic master programme. They also meet the requirements set by the professional field, as represented by the partner institutions at the Brightlands Chemelot Campus.

Conclusion
The panel assesses standard 1 'Intended learning outcomes' as satisfactory.

4.2 Standard 2 – Teaching-learning environment

The curriculum, staff and programme-specific services and facilities enable incoming students to achieve the intended learning outcomes.

Findings

Structure and contents of the curriculum

The curriculum consists of 120 EC, spread over two years of 60 EC each. See Annex 2 for a schematic overview of the programme. The curriculum is open and flexible, the range of modules will enable the students to choose a unique track and specialise in various aspects of biobased materials science, based on their academic interest and future career plans. The information dossier provides a table in which the domain-specific competences are related to the teaching modules. The panel is satisfied that this table shows how the set of mandatory and elective courses (including projects) enable the students to gain the specific competences in the four domains (biology, chemistry, materials science and application).

The programme will admit students from different bachelor programmes. Therefore, the two mandatory courses in period 1 (Biobased Materials; Molecular Biology or Materials Science, dependent on the student's background) will not only introduce the students to the field of biobased materials, but also fill possible gaps in knowledge and expertise. The mandatory courses in period 2 (Bio-organic Chemistry; Process Technology) will extend the students' knowledge, skills and expertise in the multidisciplinary field of biobased materials. The last four weeks of the first semester will be used for a peer review project: small groups of students will design a research proposal on given topics. They will assess each other's research proposals, providing feedback and proposing improvements. Both tutors and peers will be involved in the assessment of this project.

In each period of the second semester, students select two out of four elective courses. A personal coach will help each student to define a profile and select the appropriate modules. For the project at the end of this semester, research proposals from individual students will be judged by a committee of experts. Students are free to choose a biobased materials topic. The best proposals will get funded and can be executed by small groups of students. The budget for these projects will depend on the number of students that each student project coordinator is able to attract to their project.

In the first eight weeks of the second year students will again select two from four elective modules. The remaining part of the year is dedicated to the master thesis research project. This can be performed in an academic research group or with an industry partner involved in biobased materials research. The master thesis project will in total encompass 48 EC, subdivided into four separate assessed parts: research proposal (4 EC), practical research work (24 EC), written thesis (16 EC) and presentation and defence (4 EC).

The panel has looked into the course descriptions that were provided in the information dossier. During the site visit, the panel tried to gain a more detailed insight in the proposed contents of the programme. More specifically, the panel wondered if materials related physics was well enough represented in the curriculum and maybe too narrowly related to polymer physics. Based on the discussions with the programme management and the staff members,

the panel understands that the modules have been given fairly broad titles and that course coordinators have quite a lot of freedom to decide on the content of their modules. Specific information such as research with synchrotron radiation was not included in the written documents but will play a significant role as discussed with staff during the site visit. The materials science courses have been designed together with the chemistry experts in order to find the right balance. At this stage, the available staff is the starting point for the module contents, but the focus may be adjusted in the coming years, taking into account the requests of students. The explanation provided satisfactory answers to the questions of the panel.

Skills training is incorporated into the modules. Based on the information provided in the interviews, the panel is satisfied that the monitoring and assessment of skills, especially lab skills, is sufficient. The course coordinators are responsible for the link between theory and experiment in their courses and a special staff member has been hired to manage all lab skills and keep the overview, together with the course coordinators. If necessary, a student can be given additional assignments in the second project if the monitoring shows that some skills are not yet at a sufficient level.

The admission criteria and procedures have been clearly described in the information dossier. Applicants will have to provide documentation concerning their academic career, English language proficiency and motivation. In an interview, the admission officer will try to determine if there is a match between the student's expectations and motivation and the programme's ambition and multidisciplinary approach. A student who does not fully meet the formal requirements (e.g. 15 EC in mathematics at bachelor level) but who can compensate for this by other strong points in the admission file, may still be admissible. There are no special arrangements for applicants from universities of applied sciences. The programme management expects that it will be possible to remedy deficiencies during the programme, if needed, because of the small size of the group. The panel advises to monitor the students' progress closely to see if it may be necessary to offer a pre-master programme or other additional preparatory courses in the future. In more general terms, it is advisable to conduct a mid-term review of the programme as soon as the first two batches of students have graduated.

Didactical approach

The formats of problem-based learning (PBL) and research-based learning (RBL) are used as the main educational methods. They are characteristic of the teaching at Maastricht University. The active participation of the student is an essential feature of PBL and RBL and crucial to achieve the domain-specific learning goals. In PBL, the students are expected to contribute actively to group discussions in tutorial meetings and develop problem-solving skills using scientific literature and, additionally, data from their own experiments. For development of the research expertise, the students are expected to design their own experiments under supervision of the tutor/teacher. This format encourages students to take responsibility for their own experimental work and to see how the experimental work can be used to clarify the theory and concepts in the course. Ultimately, the aim is to stimulate and improve the research and life long learning attitude of the students.

Designing and executing research projects, first in small groups and later individually, prepares the students to become independent scientists. The project proposals are evaluated on innovation, relevance and practical issues. Students learn to initiate and design their own research, taking into account the available infrastructure and the need to obtain funds.

As a part of PBL, students also develop assessment skills: defining criteria for writing assignments, presentations or professional behaviour. They will be trained in peer-assessment skills, in order to create a critical attitude. At the end of the master's programme, the students will have gained the ability of self-assessment, which is an important expertise in the student's scientific and personal development. The panel is convinced that PBL and RBL are suitable for this academic master programme.

Staff

The information dossier provides a list of current internal and external staff members who will be involved in the programme. During the site visit, the panel met the programme professors and the internal staff members from the Biobased Materials Research Group and the Faculty of Humanities and Sciences. The panel was especially impressed by the energy and enthusiasm of the assistant and associate professors. They are an asset to the programme and bring in relevant networks.

Following the condition set by the Commissie Doelmatigheid Hoger Onderwijs (CDHO, Committee on Macro-efficiency in Higher Education), the faculty has complemented it's own expertise by attracting new programme professors, although only part-time, and building partnerships with research organisations and companies (Aachen Maastricht Institute for Biobased Materials, Institute for Textile Technology ITA of RWTH Aachen, Fraunhofer Institute Molecular Biology & Applied Ecology, Chemelot InSciTe with experts from the Eindhoven University of Technology and DSM, CHILL/Zuyd Hogeschool and SABIC). To the panel's opinion these steps have been very useful. The panel advises to continue the investments in full professors by hiring them fulltime and to keep building and expanding relationships with other universities.

External experts are always combined with an internal staff member. This will ensure that each teaching team has the necessary skills in PBL. In addition, it will provide continuity when teaching tasks compete with other commitments of the external expert.

During the site visit, the panel was informed that not only the assistant and associate professors, but also the full professors and PhD students contribute to the teaching programme. The integration of research and education is strong and there is a good balance between both types of activities. However, the teaching load may increase significantly when the programme really starts. The panel advises the programme management to ensure that staff members have enough time for research and networking, because this is essential for a research-driven master programme.

The panel noted during the site visit that the roles of programme leader and programme director are in good hands. After the start of the programme, for them, too, a good balance between managerial and educational responsibilities and research time should be established and maintained.

Services and facilities

During the site visit the panel was shown around the lab facilities at the Brightlands Chemelot Campus that will be available to the programme. The campus is developed by DSM, the Province of Limburg and Maastricht University. It is home to many small and large companies in chemical industry and to the Center of Expertise CHILL, organised by Hogeschool Zuyd and relevant private parties. The lab facilities are already in use for the bachelor programme of the Maastricht Science programme. The panel finds them satisfactory. The physical distance to

the university in Maastricht is apparently no problem to the currently present students or staff. It is certainly essential that the university offers a free shuttle service for students from the center of Maastricht to the Brightlands Chemelot Campus. From 2016, the facilities will be integrated into a new building, the Centre Court. This building will not only house the bachelor and master labs and education rooms, but also combine these with CHILL, DSM Innovation Centre and sport and restaurant facilities. The panel agrees that this will greatly improve the programme's facilities and the attractiveness to national and international candidates.

As indicated above (paragraph 3.4), the proximity of relevant companies will stimulate the cooperation between academia and the professional field. The companies at the Campus appreciate that academia can connect directly to industry through the recently established research group Biobased Materials. The panel finds this a strong point.

Students will have access to the general UM facilities, such as the library with its online services and the electronic learning environment EleUM-Blackboard. Students can access the administration system SLM (Student Life-Cycle Management) to view their study results, access schedules and timetables, and register for courses.

Considerations
The panel has studied the curriculum and course descriptions and concludes that the structure of the curriculum is well thought out and that the contents enable the students to achieve the intended learning outcomes. The mandatory core courses provide a basis in the relevant domains, while the elective courses and projects allow a lot of flexibility and enable the students to define their own profile. The course contents are still partially under development, but, based on the explanation provided by the programme staff, the panel is confident that they will be ready at the start of the programme. The didactic approach of PBL stimulates students to develop into independent and critical researchers with an open eye to practical and ethical issues.

The programme can draw on capable and enthusiastic staff members, covering the different domains and bringing in relevant networks. A number of part-time professors have been hired and relationships with other universities and research organisations have been established. This has obviously strengthened the knowledge base of the programme. For the sustainability of the programme, it is essential to continue these efforts, to further invest in full professors and to ensure a good balance between research and education for each staff member, including the programme management. Moreover, the professors should be encouraged to maintain and further extend their research network.

The facilities of the Brightland Chemelot Campus are currently sufficient and will be even better when the new Center Court building will be available from September 2016. A strong point is the closeness of relevant industrial companies that will in various ways contribute to the programme.

The panel concludes that the curriculum, staff and programme-specific facilities constitute a coherent, attractive and innovative teaching-learning environment for the students. This enables the students to achieve the intended learning outcomes.

Conclusion
The panel assesses standard 2 'Teaching-learning environment' as satisfactory.

4.3 Standard 3 – Assessment

The programme has an adequate assessment system in place.

Findings

System of assessment

The information dossier and the OER (Onderwijs- en Examenreglement, Education and Examination Regulations) describe the assessment system of the programme. Each module will be assessed by multiple types of assessment and at different time-points. Assessments are not yet available. As soon as the course catalogue is ready, the examination board will evaluate the range of assessments, check if the assessment methods are in line with the learning objectives and see to it that there is sufficient variety in assessment methods. All staff members have been trained in PBL and making exams and have experience at the bachelor level. Therefore, the examination board has no doubt that the assessments will be available on time.

Assessment of the master thesis will be assigned to two assessors with relevant content knowledge, one of whom is an external expert. Students will be supervised by daily advisors, who will not act as assessors for that student. The goal is to involve assessors in more than one project, in order to reach a necessary level of standardisation of grading. Guidelines for staff and students will be set out by the thesis coordinator and evaluated by the examination board before they are published. Based on their experience with bachelor theses, supervisors and assessors know the criteria for a literature review, research plan, academic writing etc. and how to give feedback. The panel has seen a draft of the thesis guidelines and is confident that these will be satisfactory. It is essential that these guidelines are available for students at the start of the programme.

Examination Board

During the site visit, the panel had an interview with the examination board. It is a strong point that the external member chairs the examination board. The chair has experience with a similar role in other programmes and stresses the board's independent role, in order to maintain quality and implement the regulations, If adaptation of the regulations seems necessary, this will be discussed with the programme committee and programme management. The regulation structure has been adopted from other programmes. For the panel, it was clear from the discussion that the examination board is well aware of the set up of the programme and its own role. The board has the intention to closely monitor the quality of the individual assessments and to check the achieved learning outcomes by selecting a random sample of master theses.

Considerations

The panel has checked the Education and Examination Regulations 2015-2016, and found these to be in order. The panel has studied the assessment system and met with the examination board during the site visit. The panel concludes that the examination board is independent and aware of its responsibilities, has developed efficient procedures and can be expected to be in control of the quality of assessment of the programme.

Conclusion
The panel assesses standard 3 ‘Assessment’ as satisfactory.

4.4 Standard 4 – Graduation guarantee and financial provisions

The institution guarantees students that they can complete the entire curriculum and makes sufficient financial provisions available.

Findings
The information dossier describes the graduation guarantee and financial provisions of the programme. In 2012, Maastricht University received a 15 million Euros subsidy from the Province of Limburg to develop a bachelor programme Liberal Arts and Sciences, a master programme Biobased Materials including research within the Aachen-Maastricht Institute for Biobased Materials, and a master programme Systems Biology including research within the Brightlands Health Campus. A further 10 million Euros will be granted if the start of the education and research is evaluated successful by the province. In 2013, these plans were integrated in a long-term investment plan for strengthening the regional economy and campus developments of the province of Limburg: the Kennis-as, with investments up to 600 million Euros. The Executive Board of Maastricht University guarantees that the financial provisions of the sciences within the Faculty of Humanities & Sciences are sufficient to cover start-up losses, even if the expected extra subsidy of 10 million Euro for the period 2016-2022 should not be available.

In the meeting with representatives from industry, the panel was able to confirm the commitment of the companies towards the programme. This was expressed by one of them who declared that the industrial partners cannot afford to ruin their reputation and let the programme fail.

The proposed budget looks feasible to the panel. The panel expects that the programme could be attractive to a sufficient number of qualified students to make the programme viable. The panel agrees that it is a sensible decision to start with a small number of fifteen students and gradually let it grow to a yearly intake of fifty students.

Considerations
The panel has ascertained that Maastricht University and a combination of public and private organisations have invested strongly in the master programme Biobased Materials, and is convinced that Maastricht University will guarantee sufficient financial provisions in the case of start-up losses. The panel is, therefore, convinced of the viability of the programme.

Conclusion
The panel assesses standard 4 ‘Graduation guarantee and financial provisions’ as satisfactory.

4.5 Final conclusion

On the basis of the information dossier and the discussions during the site visit, the panel concludes that the academic master programme Biobased Materials is an ambitious programme in a socially relevant domain, using a multidisciplinary approach and being strongly supported by regional industrial and academic partners and the provincial government. The intended learning outcomes reflect the contents and approach of the programme and are in line with the requirements of similar international programmes.

The structure and contents of the curriculum are well considered. The set of mandatory core courses is combined with a broad offering of elective courses that enable the students to select a distinctive profile. The learning objectives of the courses build up towards the programme's intended learning outcomes. The didactic approach of PBL helps the students to develop into independent and responsible researchers. The admission criteria are clear and appropriate. The quality of the academic staff and the services and facilities constitute a coherent teaching-learning environment for the students. The programme management and staff members are enthusiastic and capable. Full professors (part-time) have been hired and relationships with related research organisations have been established. The programme is still under development but based on the site visit the panel is confident that everything will be in place at the proposed starting date. The panel advises to monitor the students' progress closely in order to fine-tune the programme over the next years. The facilities at the Brightlands Chemelot Campus are satisfactory and will be expanded in 2016 when the new Center Court building comes available.

The examination board has been established and is developing procedures to actively check the quality of assessments. The Education and Examinations Rules are in order and a draft of the thesis guidelines is available. These should be finalised at the start of the programme.

Maastricht University guarantees that students who have been admitted to the programme, can complete the entire curriculum. The financial provisions are sufficient. The commitment of the province of Limburg and industrial partners is strong.

The panel's final conclusion therefore is satisfactory.

4.6 Recommendations

The panel advises:
- to include an explicit reference to the importance and implementation of green chemistry and green engineering in the intended learning outcomes;
- to monitor the students' progress closely to see if a pre-master programme or other additional preparatory courses may be necessary;
- to conduct a mid-term review of the programme as soon as the first two batches of students have graduated;
- to continue the investments in hiring full-time professors and in building and strengthening relationships with other universities, research organisations and companies;
- to make the programme sustainable by not only hiring enough staff, but also by guaranteeing a healthy balance for staff between research and teaching and administrative tasks. It is important for the success of the master's programme to strengthen the academic research environment and culture on the new campus. This can only be achieved, if the academics can invest sufficient time for research.

4.7 Advice on two-year duration of programme

Findings
Maastricht University proposes that the master programme Biobased Materials has a duration of two years (120 EC). The programme management's arguments regard the international requirements of the programme and the level of complexity of the programme, reflecting the requirements of the multidisciplinary domain of biobased materials.

The learning outcomes to be attained by the students must be consistent with the international requirements for the domain. To check the domain-specific standards in the field of biobased materials, the programme management has investigated similar master programmes internationally. This search showed there are only a few programmes that focus specifically on biobased materials or bioproduct technology (focussed on materials):
- Master Biobased Materials Science; Kyoto Institute of Technology, Kyoto, Japan;
- Master Biobased Products and Energy; University of Hohenheim, Germany;
- Master programme in Bioproduct Technology, Aalto University, Aalto, Finland.

From the comparison of these programmes it is clear that all strive for a multi- and trans-disciplinary graduate. All stress the importance of integrating research in the educational programme and include a longer period of master thesis research and internships, ranging from 30 to 45 EC. All programmes have a 2 year curriculum.

The learning outcomes to be attained by the students should enable them to compete on an equal basis with their peers from other countries. The programme management refers to the importance of practical research training and the broad multi-disciplinary approach as arguments for a 2 year curriculum. In the first place, the international standard for master programmes in the natural sciences is a strong integration of practical competence and skills training. Without this practical education, the graduates have less chance of a proper scientific career, because their education will be seen as flawed. Doing actual research is seen as one of the core competences of the graduates, which is expressed in the intended learning outcomes of the MSc Biobased Materials and the size of the research project (48 EC).

In the second place, the topic of Biobased Materials covers the complete biobased materials development chain (a broad array of disciplines that are on the interface(s) of molecular biology, chemistry, materials science and engineering, sustainability, and entrepreneurship). Students are trained in combining disciplines and having a broader view over the field of biobased materials. The graduates will become the scientists that can build bridges between the disciplines, are able to speak multiple "scientific languages" and connect specialists in multi-disciplinary groups. The need for such extensively trained and "multi-lingual" trans-disciplinary scientists has been clearly indicated by relevant companies. The companies all supported the education of the trans-disciplinary experts in the biobased scientific fields who can actually connect disciplines but still have sufficient in-depth knowledge in certain areas, which can solely be achieved in a 2 year master track. In a shorter programme, the graduates would miss many of the vital competences and skills, and therefore would have a disadvantage in forming and shaping their future career, especially when having to compete with (foreign) students who have gained the required competences and skills during their studies.

Considerations
The panel has assessed the arguments, using the criteria put forward in the Protocol cursusduur masters of NVAO, published on 8 October 2003.

The first criterion refers to the international requirements for a master programme in the relevant domain. Generally speaking, master programmes in natural sciences have a duration of two years since the introduction of the bachelors and masters in the Netherlands. Academic programmes in natural sciences in the Netherlands were set at a duration of five years (300 EC; three years bachelor; two years master), in order to allow the students to attain an international comparable level. The international standard for the programmes was five years and offering an education of four years, implying a one-year master's programme, would have put graduates of Dutch programmes in an unfavourable position compared to their peers abroad, regarding the knowledge and skills they would have acquired. More specifically for the MSc Biobased Materials, the panel regards the comparison made by the programme management to be relevant and thorough, and concludes that all similar programmes abroad take two years (120 EC). In the opinion of the panel, graduates of the proposed programme should take a two-year master's programme to achieve the learning outcomes, set at an international level.

According to the second criterion, it should be convincingly shown that the learning outcomes that enable the students to compete on an equal basis with their peers from other countries, cannot be attained in a one-year programme. The panel is convinced that the broad range of disciplines, the combination of in-depth and broad knowledge to be achieved, the competences and skills to work effectively in multi- and transdisciplinary project teams and the practical lab and research skills are essential to the programme. Since the programme is a research-oriented programme, the thesis should be the result of a substantive research project. The panel strongly feels that the qualifications the graduates should have in order for them to be competitive in the international academic job market, cannot be achieved in a programme of less than two years.

Conclusion
Given strong arguments in favour of a duration of two years, the panel advises to grant the programme the right to offer a two-year master's programme (120 EC).

4.8 Advice on sector in the Central Register of Higher Education

Findings
Maastricht University proposes that the master programme Biobased Materials be registered in the sector Nature.

Considerations
The panel confirms that the master programme Biobased Materials, building on the domains biology, chemistry, materials science and their application, fits best in the sector Nature.

Conclusion
The panel confirms the allocation of sector as suggested by the applicant: Nature.

5 Overview Assessment

STANDARD		ASSESSMENT
1 Intended learning outcomes	The intended learning outcomes of the programme have been concretised with regard to content, level and orientation; they meet international requirements.	satisfactory
2 Teaching-learning environment	The curriculum, staff and programme-specific services and facilities enable incoming students to achieve the intended learning outcomes.	satisfactory
3 Assessment	The programme has an adequate assessment system in place.	satisfactory
4 Graduation guarantee and financial provisions	The institution guarantees students that they can complete the entire curriculum and makes sufficient financial provisions available.	satisfactory
FINAL CONCLUSION		SATISFACTORY

Annex 1 – Panel

Prof. dr. J.H. (Han) de Winde (*chair*)
Han de Winde (1962) obtained an MSc in organic chemistry and biochemistry at the Vrije Universiteit Amsterdam, and a PhD in molecular biology, University of Amsterdam. He was postdoc and assistant professor at University of Leuven; principal scientist Microbial Genetics and Physiology, DSM Life Sciences RD&T while part-time chair of Industrial Genomics at Delft University of Technology. Since 2006 he was director, Department of Biotechnology, Delft University of Technology, chair of Genetics and Genomics of Industrial Microorganisms and business director of the Kluyver Center for Genomics of Industrial Fermentation. Since 2010 he is vice chairman of the Chemistry Board of the Dutch National Science Foundation. Since 2013 he is vice dean, Faculty of Sciences, Leiden University and chair of Industrial Biotechnology. Han de Winde is an expert in microbial molecular genetics and metabolic engineering, in the field of signal transduction and control of physiology, growth and development of bacteria, yeast and fungi. His expertise extends to implementation and development of Systems and Synthetic Biology in microbial strain and process improvement. He is author of over eighty scientific publications and of ten filed patents families.

Prof. dr. Bert Müller
Bert Müller (1962) obtained his MSc in Physics and MSc in English from the Dresden University of Technology, and a PhD in experimental physics, University of Hannover, Germany. He was postdoc at the Physics Department of Paderborn University, Germany and Feodor Lynen-Fellow at the Physics Department of EPF Lausanne, Switzerland, followed by leading positions within the ETH domain, i.e. at the Physics Department of ETH Zürich, Swiss Institute for Materials Testing and Research, Materials Department and Information Technology and Electrical Engineering Department of ETH Zürich. Since 2001, Bert Müller teaches at the Physics Department of ETH Zürich as 'Privatdozent in Experimentalphysik'. Since 2006 he is Thomas Straumann-Professor for Materials Science in Medicine at the Medical Faculty of the University in Basel. His teaching experience includes the Medical Faculty in Bern (Biomaterials and Materials Science), the Dental School of the University of Basel (Dental Materials and Technologies) and the Science Faculty (Nanosciences and Surface Science). Currently, he is director of the Biomaterials Science Center, head of the PhD commission and the PhD programme in Biomedical Engineering and leads a research team of almost 30 scientists from several disciplines. The research activities include high-resolution X-ray imaging, biomaterials science and engineering, and artificial muscles. He is author of more than 200 scientific publications including patents.

Prof. dr. Alexander Bismarck
Alexander Bismarck (1971) obtained a Dipl.-Chem. and his PhD in Polymer Science from the TU Berlin. He was a Research Fellow in the Colloid & Surfactant Group at The University of Hull. Prior to his first academic appointment as Lecturer in the Department of Chemical Engineering at Imperial College London, he worked as an R&D engineer for Sulzer Composites, Winterthur, CH. Currently he heads the Institute of Materials Chemistry & Research (mc.univie.ac.at) and PaCE group in the Department of Chemical Engineering at Imperial College (www.ic.ac.uk/pace). He is Editor of Reactive and Functional Polymers and on the Editorial Boards of Composite Science and Technology, express Polymer Letters, Polimery, and Materials. He taught at the TU Berlin, in Hull, Imperial and Vienna, Physical Chemistry, Colloid and Interface Science, Polymer Chemistry and Engineering and problem

solving skills. His research interests range from green materials to advanced high performance composites.

Drs. C.J. (Renée) Verhoeven (*student member*)
Renée Verhoeven (1987) started her academic career in 2005 as a Dutch Law student at Tilburg University. In 2007 she started studying Medicine at the Erasmus University Medical Center in Rotterdam. Belonging to the top 10% of best performing students of her year, Renée was selected to combine a Research Master in Clinical Research at the Netherlands Institute for Health Sciences (NIHES) with her medical training. Her Master Thesis on biomarkers in liver transplantation was awarded as the best NIHES Master Thesis in Clinical Research in 2012 with an 'outstanding' thesis defence. From 2012-2014 she continued her research on biomarkers as a PhD student, for which she received multiple awards on both national and international conferences, as well as a travel scholarship to obtain research experience at the University hospital of Zürich, Switzerland. Since 2014, Renée is a member of the basic science committee of the International Liver Transplantation Society (ILTS) for which she organises state of the art symposia on basic science in liver transplantation at international conferences. Next to her study, Renée volunteers in teaching surgical abdominal anatomy classes for medical students. After finishing her medical study and PhD research at the end of 2016, Renée intends to pursue a career in a surgical related field.

Assisting staff:
- Dr. Marianne van der Weiden, secretary to the panel;
- Michèle Wera MA, policy advisor NVAO and process coordinator.

All panel members and the secretary signed a declaration of independence and confidentiality prior to the assessment process.

Annex 2 – Overview of the programme

First year MSc Biobased Materials (total 60 EC)

8 weeks	8 weeks	4 weeks	8 weeks	8 weeks	4 weeks
Compulsory courses	Compulsory courses	Project	Electives	Electives	Project
1. Biobased materials 2. Molecular biology or 2. Materials science	1. Bio-organic chemistry 2. Process technology	Student research (group)	Choose 2 from 4	Choose 2 from 4	Student research (group)
2 x 6 EC	2 x 6 EC	6 EC	2 x 6 EC	2 x 6 EC	6 EC

Second year MSc Biobased Materials (total 60 EC)

8 weeks	32 weeks
Electives	Master Thesis Research Project
Choose 2 from 4	Individual student research project
2 x 6 EC	48 EC

Annex 3 – Programme site visit

Thursday 30 April 2015, Geleen, Brightlands Chemelot Campus, Building 110, room 2.140

12.00 – 15.00 Preparatory meeting panel during lunch (closed meeting)
(3hrs)

15.00 – 15.45 Short presentation new programme and concept of problem-based learning
(45')

- Dr, Yvonne van der Meer, Programme leader Biobased Materials
- Dr. Menno Knetsch, Programme director master Biobased Materials
- Drs. Fred Offerein, Managing director Sciences

15.45 – 16.15 Tour through the buildings and facilities
(30')

- Paul Lemmens, Lab manager Maastricht Science Programme teaching labs at Chemelot
- Dr. Menno Knetsch, Programme director master Biobased Materials
- Prof. Thomas Cleij, Dean Maastricht Science programme, Faculty of Humanities & Sciences
- In lab 110 Dr. Jules Harings and Dr. Dietmar Auhl, Assistant professors Biobased Materials
- In lab 93: Dr. Katrien Bernaerts, Assistent professor Biobased Materials

16.15 – 17.00 Preparatory meeting panel (continued)
(45')

17.00 – 17.30 Representatives of the faculties of Humanities and Sciences (FHS)
(30')

- Prof. Franz Palm, Professor Econometrics and Dean Faculty of Humanities & Sciences
- Prof. Sanjay Rastogi, Professor Polymer Physics, Biobased Materials
- Prof. Stefan Jockenhövel, 'figurehead' Biobased Materials, Aachen Maastricht Institute for Biobased Materials (AMIBM) and Professor Tissue Engineering & Textile Implants, ITA and AME, RWTH Aachen University
- Prof. Thomas Cleij, Dean Maastricht Science programme, Faculty of Humanities & Sciences
- Drs. Fred Offerein, Managing director Sciences

17.30 – 18.00 Representatives of the professional field
(30')

- Dr. Rinus Broxterman, DSM, Coordinator Biobased Products
- Dr. Klaas Remerie, SABIC Technology & Innovation
- Dr. Bert Kip, CEO Brightlands Chemelot Campus BV

Friday 1 May 2015, Maastricht Kapoenstraat 2, room 0.024 (MSc building)

09.00 – 09.45 Programme management and designers curriculum
(45')

- Dr, Yvonne van der Meer, Programme leader Biobased Materials
- Dr. Menno Knetsch, Programme director master Biobased Materials
- Drs. Fred Offerein, Managing director Sciences

10.00 – 11.00 Staff responsible for courses (mandatory and electives), projects, and thesis
(60')

- Dr. Katrien Bernaerts, Assistant professor, Biobased Materials
- Dr. Jules Harings, Assistant professor, Biobased Materials
- Dr. Dietmar Auhl, Assistant professor, Biobased Materials
- Dr. Stefaan de Wildeman, Associate professor, Biobased Materials
- Dr. Karel Wilsens, Assistant professor, Biobased Materials

11.15 – 11.45 Representatives of the Programme Committee
(30')

- Dr, Yvonne van der Meer, Programme leader Biobased Materials
- Dr. Stefaan de Wildeman, Associate professor, Biobased Materials
- Dr. Karel Wilsens, Assistant professor, Biobased Materials

12.00 – 12.30 Representatives of the Examination Board
(30')

- Prof. Ralf Peeters, Professor in Mathematical aspects of knowledge engineering and Vice Chair Department of Knowledge Engineering, Faculty of Humanities & Sciences
- Dr. Jules Harings, Assistant professor, Biobased Materials
- Prof. Thomas Cleij, Dean Maastricht Science programme, Faculty of Humanities & Sciences

12.30 – 13.30 Lunch and meeting panel (closed meeting)
(60')

13.30 – 13.45 Extra session with programme management
(15')

- Dr, Yvonne van der Meer, Programme leader Biobased Materials
- Dr. Menno Knetsch, Programme director master Biobased Materials

13.45 – 15.30 Final panel meeting (continued)
(1.45')

15.30 – 15.45 Feedback session
(15')

- All interested UM staff involved in the master

Annex 4 – Documents reviewed

- Accreditation file (information dossier)
- Information on course duration master Biobased Materials
- Brochure MSc Biobased Materials
- Example of PBL task: CHE1001 Introduction to Natural Sciences: Chemistry, Task 1 Observing atoms
- Education and Examination Regulations (update)

Annex 5 – Abbreviations

ba	bachelor
EC	European Credit
ma	master
NVAO	Nederlands-Vlaamse Accreditatieorganisatie (Accreditation Organisation of the Netherlands and Flanders)
PBL	Problem Based Learning
RBL	Research Based Learning
UM	University of Maastricht
wo	wetenschappelijk onderwijs

This panel report was commissioned by NVAO for the initial accreditation of the wo-master's programme Biobased Materials of Maastricht University.

NVAO
Accreditation Organisation of the Netherlands and Flanders
Parkstraat 28
P..O. Box 85498
2508 CD THE HAGUE

Tel. +31 70 312 23 00
Fax. +31 70 312 23 01
E-mail info@nvao.net
Web www.nvao.net

Application number 003695