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ACCREDITATION AGENCY

## **EXTERNAL EVALUATION REPORT**

MATERIALS SCIENCE DEPARTMENT

UNIVERSITY OF PATRAS

September 2013



**European Union**  
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MINISTRY OF EDUCATION & RELIGIOUS AFFAIRS, CULTURE & SPORTS  
MANAGING AUTHORITY



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### **External Evaluation Committee**

The Committee responsible for the External Evaluation of the Materials Science Department of the University of Patras consisted of the following five (5) expert evaluators drawn from the Registry constituted by the HQAA in accordance with Law 3374/2005 :

1. Professor Mercouri Kanatzidis (Coordinator)  
(Title) (Name and Surname)  
Northwestern University, USA  
(Institution of origin)
  
2. Professor Manos Mavrikakis  
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3. Professor Michael Zervas  
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University of Southampton, UK  
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4. Professor Angelos Efstathiou  
(Title) (Name and Surname)  
University of Cyprus, Cyprus  
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5. Dr. Alexis Stassinopoulos  
(Title) (Name and Surname)  
Assoc. of Manufacturers of Packaging and Materials, Athens, Greece  
(Institution of origin)

## ***Introduction***

### I. The External Evaluation Procedure

The External Evaluation Committee (EEC) visited University of Patras (UoP) between September 16 and 18, 2013.

On Sept. 16<sup>th</sup>, the EEC met with the Rector of UoP, Prof. G. Panagiotakis, vice-Rectors, Profs. P. Kyprianos and I. Daouli-Demousi, the Dean of School of Natural Sciences, Prof. Ch. Kordoulis, the Chair of the Department of Materials Science (DMS), Prof. N. Vainos, and other members of the Internal Evaluation Committee, IEC (OMEA and MODIP). The same day, the committee attended departmental presentations and asked questions during and following these presentations on the: (1) Current status of the Department, and (2) a historical perspective and evolution of the Department.

On Sept. 17<sup>th</sup>, the EEC attended presentations providing detailed information on the undergraduate and graduate programs, an extensive set of research presentations grouped together on the basis of underlying research themes. The same day, the committee met in groups with various Departmental faculty and staff, including staff of the secretariat, Lecturers, Assistant Professors, Associate Professors, and ETEP personnel. The committee was indeed pleased with the broad participation of all departmental personnel in the external evaluation process, including the open discussions which took place as part of this process.

On Sept. 18<sup>th</sup>, the EEC met with the Full Professors of the Department, and attended further presentations focused on outreach and the practical training program for the undergraduates of the department. In addition, the committee visited both instructional and research laboratories and conducted on-site discussions with researchers, including diploma, MS, and PhD students. The committee visited briefly the Departmental library and the computer center and laboratories of the Department. The committee was unable to meet with large group of undergraduate students mainly for two reasons: (1) this was the exam period, when students are not easily available, and (2) certain groups of the students were fundamentally opposed to the evaluation process/concept, as explained in a document distributed and posted around the Department during the committee's visit. At the end of the visit, the committee met again with Rector Panagiotakis, vice-Rector Prof. P. Kyprianos, the Dean of School of Natural Sciences, Prof. Ch. Kordoulis, the Chair of the Department of Materials Science (DMS), Prof. N. Vainos, and other members of the Internal Evaluation Committee, IEC (OMEA and MODIP). During this exit interview, the committee provided initial feedback and selected suggestions for improvements to the University and Departmental representatives.

The EEC was provided with copies of the IEC reports, the departmental Study Guide (Οδηγό Σπουδών), lists of textbooks used in courses, copies of all presentations, data on grants, instrumentation, building facilities, research and other expenditures, and some information on the placement of students who have graduated from the Department in recent years.

### II. The Internal Evaluation Procedure

The IEC did a very thorough job in collecting a wealth of information pertaining to all aspects of Departmental life. The main IEC report covered the 5-year period between 2007-2011, and was dated 12/12/2011. To supplement that information, the EEC was

provided with detailed additional yearly reports for academic years 2011-12, and 2012-13. This extensive information included external bibliographic databases such as ISI's Web of Science, Scopus, etc. Very detailed and up-to-date documentation was also provided on undergraduate and graduate curricula, teaching and research activities for each faculty, administrative services, facilities, including computer labs and libraries, outreach and practical training, and plans for improvement.

The objectives of the internal evaluation process were met fully. The department committed an undoubtedly large amount of time and energy to prepare all this documentation, a sign that this unit is clearly welcoming and actively pursuing the external evaluation process.

## **A. Curriculum**

*To be filled separately for each undergraduate, graduate and doctoral program*

### **A1. Undergraduate Program**

#### **APPROACH**

- Goals and objectives of the Curriculum

The goals and objectives of the undergraduate program of the Department of Materials Science (TEY) at the University of Patras since its establishment in September 1999, is to bridge the gap between traditional technologies and the modern nano-sciences and nano-technologies in the field of materials. The curriculum is thus shaped according to these objectives, and targets the basics of the fundamental sciences of physics and chemistry as well as the main concentration areas of the Department related to *micro-phase* and *nano-phase* materials, *molecular* materials, *biophase* and *biomaterials*.

- Plan for achieving excellence

The structure of the curriculum is based on three pillars: (i) basic and introductory courses in Physics, Chemistry, Biology, Mathematics and Computer Science, (ii) a sequence of courses in Materials Science and Technology, and (iii) a series of elective courses covering all the specific areas in Materials Science and Technology addressed by the program. The current curriculum addresses to a large degree the objectives of the TEY, and follows in general the structure of several other internationally recognized 4-year programs in Materials Science and Engineering. Since the academic year 2004-2005 the curriculum adopts the European Credit Transfer System (ECTS).

The undergraduate laboratory training is good in both the introductory and advanced level. The material used in classroom and laboratories is updated regularly, and consequently the curriculum is kept current. The ratio of lecture-based to experimental ECTS is ~ 2.2:1, which is considered appropriate. The ratio of the mandatory to elective courses within the Department is also appropriate (~ 2.5).

- How were the objectives decided? Which factors were taken into account? Were they

set against appropriate standards? Did the unit consult other stakeholders?

The specific curriculum has been formulated considering the international upsurge in the interest in Materials Science and Engineering putting emphasis on nanoscale phenomena and the expected significant innovations in nanotechnologies, not represented to a large degree on a national basis. The curriculum has been revised to a large extent and put in effect during the academic year 2005-2006 in order to reflect the current-state-of-the art in the targeted areas mentioned above. This revision process was led by an appointed Departmental Curriculum Committee, which also considered comments provided by an International Advisory Board appointed to evaluate the progress of the TEY (2000-2003). The EEC also recommends some improvements.

- Is the curriculum consistent with the objectives of the Curriculum and the requirements of the society?

The selection of the courses is in agreement with the objectives of the curriculum but some improvements should be considered (see Recommendations). The curriculum includes an optional practical training course (3 ECTS), and a research dissertation (16 ECTS). The latter can also be performed through the ERASMUS and the ERASMUS Placement programs. These provide the opportunity to young material scientists to interact with local and national industry, and with modern experimental techniques used in leading foreign laboratories.

## **IMPLEMENTATION**

- How effectively is the Department's goal implemented by the curriculum?

In recent years (2008-2012) the number of students admitted in the TEY is approximately stable (~120-130 students), providing a ratio of students to faculty of about 28. However, this number increases substantially (~48) after considering the real number of students who are not able to complete their studies in 4 years.

The course content and the curriculum appear to be good overall based on the course descriptions made available to EEC; unfortunately, no feedback was received by the students during the on-site visit for reasons provided in another section of this report. The EEC notes that the ratio of compulsory course-hours related to the chemistry of materials (e.g. synthesis of nanomaterials) relative to those dealing with the physics and engineering of materials (e.g. optical, thermal and mechanical properties, manufacturing) is lower compared to many other international curricula in Materials Science. The courses are taught by faculty who are experts in the field, and most of the instructional labs are equipped with good instrumentation.

The students' attendance and the actual number of students taking examinations are low. Therefore, the success rate of getting a passing grade in classes is low and below acceptable international levels. This is the result of (i) lack of attracting students who declared Materials Science as their first priority, (ii) weak to medium background of entering students related to the main disciplines of Materials Science and Engineering, and (iii) uncertain future employment due to the yet not well established and respected brand of the Materials Science degree and profession in Greece. The EEC also realizes that this trend is a national rather than a local one.

- Does the Department have the necessary resources and appropriately qualified and trained staff to implement the curriculum?

The biggest problem of the Department is the lack of appropriate and qualified space building according to international standards, and the shortage in technical (not professorial) personnel (ETEII). The undergraduate labs appear to be well equipped and are managed by exceptionally qualified technical staff (2). However, good maintenance of the labs and the need for upgraded equipment or additional equipment is a concern, because of the lack of adequate funding. The instructors have high qualifications and expertise for teaching of the courses of the curriculum.

## **RESULTS**

This is a relatively new department (1999 ) and no long-term statistics are available on the employment of its graduates. There is also a practical difficulty in keeping a track record in the employment of graduates by both the Department and the central University services. The EEC found that less than 30% of the admitted students graduated in 6 years (2000-2007), and only 0-6 students graduated in four years (2005-2013), with most of the students graduating between 7 and 10 years. A fraction of the graduates continued with post-graduate studies in other national (13) and foreign Universities (22), to mention University of Oxford (UK), University of Southampton (UK), Technical University of Dresden (Germany), University of Poitiers (France), and University of Twente (The Netherlands). Several of the graduates were employed by local industry related to materials science and technology, and three graduates were employed in Education under the 407/80 Law.

Unfortunately, no feedback from the students was possible regarding these low figures. Even though the EEC had scheduled to interview a number of undergraduate students, this was finally not accomplished. A significant delay in the EEC's agenda (17/9/2013), the strike of academic staff on Wednesday (18/9/2013) cause cancelation of ongoing exams for that day, and the departure of students from the premises due to the long delay contributed to this problem.

## **IMPROVEMENT**

As noted earlier, the Department has taken the necessary steps to upgrade and improve the curriculum, and a significant progress has already been achieved. The undergraduate program in its current state is considered to be competitive in several subjects within the fields of nano-sciences and nano-technologies, and provides a good background for successful post-graduate studies. On the other hand, the employment of its graduates in the local private sector seems to be problematic. Part of this is undoubtedly due to the current hardship in the general Greek economy.

Efforts should be made towards the introduction and/or modification of a number of course material in order to meet the local industrial needs. Below, the EEC proposes several steps that are aimed to improve the undergraduate program.

### ***Recommendations***

1. The number of admitted students should be decreased to 50.

2. An effort should be made to improve the quality of admitted students by accepting students with the proper background. For example, it is entirely unacceptable to allow entering students with no or very weak background in Chemistry, Mathematics or Physics.
3. A number of pre-requisite courses in compulsory courses should be introduced. This will help to shorten the time to degree.
4. Homework assignments to the students should be increased significantly and mid-term exams should be established in all courses.
5. The introduction of new material in courses related to the synthesis, characterization, and process technology regarding several materials used and manufactured by the Greek industry.
6. The number of ECTS related to Chemistry courses in nature, and in particular to those dealing with the synthesis of materials used in important technological applications, should be increased.
7. The instructional labs should be often upgraded with modern instrumentation and all the instruments should be properly maintained. Funding should be provided for both activities.
8. The Diploma Thesis should be made a mandatory course when the number of students is such that every faculty is able to supervise 3-4 students.
9. The EEC feels that compared to top programs in Europe and the USA, the curriculum is somewhat excessive in the number of courses, both mandatory and electives. The number of courses that students take should be reduced in order to allow more in-depth coverage and better retention of the information. This will require a careful consideration in order to meet the required ECTS (240) by University rules.

## **A2. Postgraduate Program**

The objective of the current postgraduate program is the education and training of scientists in the field of science and technology of materials that include: micro- and nano-phase materials, molecular materials, and bio-materials.

The postgraduate curriculum consists of the following two programs:

- A) Master of Science (M.Sc.) degree of specialty (MΔE)
- B) Ph.D degree

The Department accepted 31 graduate students (MΔE) during the period 2007-2013 (~ 5 per year), and 29 doctoral students (PhD level) during the period 2006-2013 (~ 4 per year).

The structure of the MΔE curriculum includes four core advanced courses (40 ECTS), elective advanced courses with mandatory participation (40 ECTS), and mandatory diploma thesis (40 ECTS) written in Greek. For the award of a PhD degree, at least one publication in refereed international journals is required.

Both diplomas are driven by excellence in research. This is reflected in the impressive number of publications in international high-impact journals.

The Masters degree does not satisfy several needs of the Greek industry, which in many cases does not need the sophistication of a PhD degree. The PhD degree is usually more appropriate for the preparation of students for academic and high technology industrial

careers.

The EEC proposes several steps which could improve the postgraduate program.

### **Recommendations**

1. The Department should consider a requirement making the number of accepted/published papers in international peer-reviewed journals required for PhD completion larger than one; -exceptions could apply in the case of a single landmark publication
2. A professional MSc degree in Materials Science (with tuition fees) could be developed to meet the main current needs of the Greek industry. This could result in significant revenues for the further development of research within the Department.
3. An effort should be made by the University to substantially increase the number of scholarships allocated to the Department according to its excellence in research.
4. The stipend support should include teaching duties for the running of the undergraduate laboratories. This will partially alleviate the shortage in ETEII personnel.
5. The Department, with the help of the University, should make extra efforts to recruit high quality undergraduate students - via better advertisement, offering fellowships and other special incentives.
6. Assuming that some financial resources to pay for travel expenses and honoraria for the seminar speakers is guaranteed, a regular, Departmental seminar series should be implemented to meet the needs of both the MSc and PhD programs
7. The EEC feels that the Department should strengthen the informal scientific interactions among students, faculty and staff of the research groups within the Department. This could include joint group meetings, cross-group journal clubs, an internal seminar series, whereby MSc and PhD students present their research on a rotating basis, and an annual poster symposium with awards.
8. Given the necessary resources, the Department should support the participation of students in national and international conferences.
9. Efforts should be made to facilitate the enrollment of foreign students to the graduate programs

## **B. Teaching**

### **UNDERGRADUATE**

#### **B1. APPROACH**

The primary goal of the Department is to provide students with the fundamentals behind materials structure and properties, while positioning itself in a cross-cutting manner in the fundamental sciences such as: Physics, Chemistry, and Biology. The early part of the core/required courses goes to achieving an enhanced background in these three disciplines. Subsequent coursework focuses on more applied knowledge. Both lecture and experimental laboratory courses are well represented in the 4-year curriculum.

Faculty and instructional staff use both standard blackboard and powerpoint presentations for teaching their classes. Laboratory courses are well-thought out and designed by the staff

to teach the students the essentials but also a bit more advanced topics which may trigger their curiosity for further independent studies. For instance, the committee members were impressed by the choice of laboratory exercises in physics, whereby several of the exercises demonstrated Nobel Prize winning, classic by now, experiments.

Experimental courses aside, the majority of the grade in each course tends to come from the final examination. Apparently, and despite the fact that several of the faculty have tried instilling the mentality of midterm exams, this has not been rooted to the culture of the department yet. More advanced elective courses include substantial portion of the grade coming from mini projects, including literature review on specific topics.

Diploma thesis is an option which an increasing fraction of the student body is pursuing. Students learn from summarizing the literature in a certain thesis topic, and if they choose a second semester of Diploma thesis, they also perform original research under the guidance of the supervising faculty. This represents a first-rate opportunity for faculty to inspire undergraduate students and teach them the excitement of original discovery. Among the very positive aspects of this activity is that there is already a growing list of archival publications, co-authored by undergraduate students who pursued the specific research within the framework of their diploma thesis.

Given the severe space constraints the Department is faced with, in combination with the excessive number of students admitted to the program (more than double the number of what resources can comfortably accommodate), there is an enormous strain on the whole system to sustain the quality of training the faculty is striving for. The problem is more pronounced in laboratory courses, whereby faculty have to form larger teams of students performing a given exercise, in order to accommodate them all within the semester timeframe. This significantly reduces the laboratory experience and has a negative impact on quality.

Overall, 17 faculty plus two ETEP members are responsible for teaching approximately 800 active undergraduate students, at the present time. This corresponds to ~47 active students for each faculty/ETEP. Clearly this ratio is very high and needs to be reduced by hiring more faculty/ETEP, by decreasing the number of admitted students and by increasing the available resources for each, mainly laboratory course.

The small number of students who met with committee members appears to be pleased with their overall learning experience. The EEC notes that because our visit coincided with the student exams period, it was unable to speak to a large number of students collectively. In addition, The EEC noticed announcements posted throughout departmental facilities that a certain fraction of students was fundamentally opposing the external evaluation process.

The laboratory facilities are well maintained by trained technical personnel. The technical staff has graduate degrees (MS and PhD) and is energetic and very enthusiastic about fulfilling their difficult mission.

There is a computer laboratory maintained by a very dedicated and well-trained (PhD) ETEP staff. The number of PCs in the laboratory is very small for the overall number of active students. Further, there is only a small number of classrooms in the premises of the Department, which given the size of a regular class necessitates teaching of major core courses in different buildings scattered throughout campus; not an efficient situation, clearly.

#### Graduate studies

The postgraduate studies program aims to the award of an autonomous postgraduate MSc-equivalent degree, as well as, to the introduction and preparation of post-graduate students

for their doctoral studies and degree.

Given the inter-disciplinary nature of the Department, the postgraduate teaching philosophy is to first homogenize the knowledge and bring students with different theoretical and experimental backgrounds to a common level of academic preparation. It also provides students with the required theoretical and practical knowledge for the modeling, theory, synthesis, structure, and characterization of microstructured and nanostructured materials, molecular materials and biomaterials, which consist the three main directions of the departmental research profile.

The postgraduate studies program duration is four semesters and leads to the award of a postgraduate specialization degree (equivalent to MSc). The program accepts students with degrees from Greek universities and from Universities abroad in quite diverse topics such as Physics and Math, Engineering, Medicine, Biology, and Geology. A requirement for the enrollment is sufficient knowledge of the compulsory courses of the undergraduate syllabus.

To maintain a high level of performance, the postgraduate student admission is based on a multitude of academic factors. It includes the applicant final undergraduate grade, the grades obtained at the undergraduate courses required by the postgraduate program, their final undergraduate year project grade, and any additional research activities and results already achieved.

The pinnacle of the postgraduate program is the studies leading to the PhD degree. Although these studies are predominantly based on original research and novel results, they are heavily based on and interlinked with the knowledge and skills acquired during the postgraduate studies program. This program (or an equivalent MSc degree) is therefore required for the enrollment to the PhD program.

## **B2. IMPLEMENTATION**

### Undergraduate studies

The language of instruction for undergraduate courses is Greek. Yet, a good fraction of the texts that were showcased for the committee's inspection were classic textbooks in English or translated versions of the originals. This is excellent practice, demonstrating the high standards of the faculty for the education of their students.

There is a large abundance in undergraduate courses being offered, which can be a benefit for the students. However, there is an optimum, in the sense that every hour going to instruction is lost from research. Therefore serious thought needs to be given to reducing the number of courses without harming the undergraduate program. The EEC believes this is possible. The EEC suggests that a balanced combination of research and teaching is the best way to propel the Department to higher levels of accomplishment and international visibility (international rankings). Individual faculty at the most respected international institutions teach 3 hours per week over the entire academic year. The rest of their time is devoted mainly to research and supervising of students. To compete with these institutions, the system needs to be changed accordingly.

The availability of optional practical training establishes a direct link between University level education and industrial practice. Accordingly, the availability of Diploma Thesis courses provides a direct link between education and research. Both activities are well

implemented and should be further enhanced.

Faculty members have extensive collaborations both with other Greek and International institutions. These connections facilitate student training at various institutions, should they wish to pursue that activity. Currently, there is active participation in the ERASMUS exchange and ERASMUS Placement programs, but unfortunately, budget limitations pose substantial limitations to participation of undergraduate students in this excellent venue for professional development.

#### Graduate studies

The postgraduate teaching philosophy is implemented by the introduction first of compulsory courses to achieve the knowledge homogenization and a number of optional courses in order to align the teaching with the main research activities in the areas of micro-/nanostructured materials, molecular materials and biomaterials.

To provide a higher specialization and alignment with the strong research basis of the department, the postgraduate studies program consists of 6 required compulsory courses and 10 optional courses. The teaching methods include traditional lectures presented either on the blackboard or in the form of PowerPoint presentations. The lectures are supplemented by laboratory demonstrations and hands-on practical assignments. A summary of course description is given in the provided "Student Guide." The last two semesters of the program are dedicated to the thesis.

The postgraduate students who met with the members of the committee unanimously expressed satisfaction with the availability of their lecturers in and out of classroom and their willingness to help with their work and provide extra tutoring and guidance.

The quite extensive teaching, experimental, advanced laboratory and computing facilities used by the postgraduate students are well maintained by the heroic and beyond-duty actions of two well-trained and qualified technical personnel. Both the technical staff has PhD degrees in physics or engineering. The committee met with the technical staff and was extremely impressed by their enthusiasm and positive attitude despite the huge work load and diversity of their duties. Their strong drive is demonstrated also by the fact that despite all these adversities they even find time to do their personal research and contribute to the research output of the department.

The postgraduate teaching and training is supplemented and benefits from access to the well maintained research infrastructure of the department. This includes clean room facilities with environmental scanning electron microscopy (SEM), scanning tunnelling microscopy (STM), and atomic force microscopy (AFM). Due to the complexity, sensitivity and high cost of these facilities access to them is obtained under the strong supervision and guidance of experienced and well trained technical personnel. In the optional courses, the students also benefit from their exposure and access to extensive photonics facilities and laboratories such as photoluminescence workstation, UV/VIS spectrometer, ATR/FT-IR spectroscopy, dielectric spectroscopy, ultrahigh vacuum laser deposition, excimer laser microfabrication facility. In addition the postgraduate student studies and research program benefits from access to high quality facilities such as thermal analysis suite, dynamic mechanical analysis, high pressure liquid chromatography, high temperature multi-zone thermal processing, Au/C sputtering, high speed programmable spin coating and chemical synthesis. These

facilities provide the possibility of world-class student training.

The theoretical training and teaching benefits from access to multicore, high-speed computer clusters for advanced and extensive modelling. There is also one computer laboratory with 25 well maintained terminals with free over extensive period access by all postgraduate students for word and other low-level processing.

Teaching is supported by an extended list of world-class suggested international bibliography. The postgraduate teaching materials and resources are regularly updated to incorporate latest scientific and technological advancements in the areas of interest. The course material is also revised and updated to include latest results from the lecturer's personal research.

A commendable feature of the teaching procedure is the introduction of courses (in conjunction with the semester 7 and 8 undergraduates), such as "Industrial Applications of Materials", taught entirely by experienced and qualified industry representatives followed or complimented by strong student interaction and visit to industry.

### **B3. RESULTS**

#### Undergraduate studies

The designed curriculum of the Department, combined with effective teaching methodologies including lecture-based and laboratory courses leads to a solid education of the undergraduate students admitted to the program. This is demonstrated by the satisfaction of the employers of the students and the success of a good fraction of these students in pursuing competitive placement in post-graduate programs both in Greece and abroad. The average GPA for graduating students of the Department ranges between 6.5 and 7.3, with an average of 6.76, which is remarkable given the absolute grading scheme implemented in Greek Universities and the modest academic record of incoming students out of high school (on average).

The average time to graduation has been decreasing since the establishment of the Department and seems to have stabilized at around 6 years. The EEC feels that the implementation of the new law which imposes stricter limits to inactive University students will tend to decrease the time to graduation even further, thereby approaching more reasonable times, comparable to those characteristic to international institutions with educational systems similar to that of Greece.

There is a growing list of good quality of archival publications, co-authored by undergraduate students who pursued the specific research within the framework of their diploma thesis. Importantly, public defense of the diploma thesis helps sharpen much needed presentation skills of young undergraduates.

#### Graduate studies

Teaching of the postgraduate courses in the Department is taken extremely seriously and it is done in a methodical way using established teaching techniques. The teaching benefits from the experimental work in the courses and the training obtained in the very good experimental facilities. This results in highly-skilled graduates in a number of theoretical and experimental techniques that can be potentially employed in a wide range of industrial material related sectors in Greece and elsewhere in Europe. This

way the program contributes significantly to the industrial and manufacturing sector of the Greek economy.

In addition to direct employment, the postgraduate studies program provides all the required theoretical and experimental background for the graduates to continue their studies to a higher PhD level. In the period 2007-2013 there have been 21 MSc graduates and 25 PhD students. From the 21 MSc graduates, 10 graduates were directly employed in industry and the rest continued to PhD level. The average graduation grade was around 8 (out of 10).

A strong indicator of the quality of teaching in the MSc level and the strong link to research is the number of MSc projects that result in publications and the large number of graduates continuing to the PhD level.

It should be finally stressed here that through the heroic actions and enthusiasm of the technical support personnel and the extreme dedication of the heavily overloaded teachers, the teaching quality of the postgraduate studies has achieved very high level of international standards, despite the very low budget and the extremely poor quality of the existing building infrastructure.

#### **B4. SUMMARY AND RECOMMENDATIONS**

##### Undergraduate studies

##### SUMMARY

1. The current faculty and ETEP succeed in training an excessive number of undergraduate students. Despite the modest academic background and GPA of incoming students, a significant fraction of the students manage to complete the program within a reasonable amount of time, primarily thanks for the dedication of the faculty/ETEP to their mission.
2. A good variety of teaching methods is being used.
3. Evaluation of student learning is more distributed over the year in laboratory courses. Evaluation of student learning in lecture courses takes place mainly at the end of the course term.
4. The external internship program is well structured and offers very good training opportunities to students able to participate. Budget limitations have diminished the impact of the internship program lately.

##### RECOMMENDATIONS

1. The quality of training and time to graduation can both be improved by drastically decreasing the number of students admitted to the program. This will also raise the average quality of incoming students.
2. Faculty should launch a systematic effort to increase attendance of lectures and student engagement in learning during the entire academic year, by encouraging participation in homework assignments and by establishing mandatory midterm

exams. Both elements could enhance the learning experience. As currently practiced, stand-alone studying by the students near the end of the semester only, does not foster active student-faculty scientific exchange spread over the entire semester.

3. Funds need to be secured urgently for re-invigorating the practical training experience in industry, which gives students a great idea of what they are going to be doing during their careers in a typical Greek industry.
4. More resources need to be secured, so that more students of the Department can participate in the ERASMUS exchange and ERASMUS Placement programs. This is a fantastic opportunity for the students to not only experience how learning is pursued in different industrially advanced nations, but also exposes them to different cultures and general attitudes of life in other European countries; an experience with transforming potential for young individuals.
5. To become more competitive on a global scale, teaching load of individual faculty needs to be decreased, so that time can be saved and used towards research related activities, which in turn can further enhance the visibility and recognition of the department in their peer community and eventually reflected in the international disciplinary rankings.
6. To increase the influx of ERASMUS students to the department, the faculty may wish to consider teaching a set of advanced optional courses in English.
7. Efforts should be made so that students get access to their textbooks earlier in the semester than currently practiced.
8. Faculty noted that there are no major pre-requisites for more advanced core courses. Although this may be practical for most cases, the committee feels that this general policy may need to be re-evaluated for a more natural progression of students through the well-thought curriculum already set in place.

#### Graduate studies

##### SUMMARY

5. The department provides high quality postgraduate teaching, tailored to the individual student needs by offering a large number of optional courses covering the three main research streams.
6. The courses are taught by world renowned researchers and experienced teachers and benefit from their advanced knowledge in various aspects of material science.
7. The postgraduate student comments in interviews by members of the EEC, regarding the teaching quality, were very positive.
8. An appropriate range of standard teaching methods is being used.
9. The external internship program and interaction with industry compliments extremely well the other teaching practices.

##### RECOMMENDATIONS

9. Consider to deliver the MSc course in English to increase the pool of high quality students, increase the international status of the Department and the University at large. Introduction of moderate amount of fees and use this income to improve experimental facilities or support students in need.
10. Improve the quality of building and teaching facility infrastructure in order to

increase the profile of the MSc course and attract larger number of students.

11. Consider connecting with other institutions in Greece or abroad in order to increase the exposure of the MSc student to a larger variety of practices and scientific culture.
12. Increase the role of and seek more advice from industry in updating the MSc curriculum and the required skills.

### **C. Research**

*For each particular matter, please distinguish between under- and post-graduate level, if necessary.*

#### **APPROACH**

- What is the Department's policy and main objective in research?

The Department's main objectives in research are to develop an internationally recognized program three identified interdisciplinary areas, namely microphase and nanophase materials, molecular materials and biomaterials. The research activities also aim at leading the way forward beyond the traditional fields, already established at the University of Patras, towards tomorrow's nano-science and nano-technology.

- Has the Department set internal standards for assessing research?

The quality of the research is assessed by the number and impact factor of the resulting publications as well as the number of citations the published research attracts. The faculty also is encouraged to apply for independent funding and run larger projects.

#### **IMPLEMENTATION**

- How does the Department promote and support research?

Given the very limited funds and resources available, the Department is trying to maximise the return and benefits to research by channelling the available funds in certain strategic areas and acquiring relatively large pieces of equipment which can be widely used and benefit the research quality. All faculty is guaranteed access to the equipment. This way the Department encourages, promotes and in a sense enforces collaboration between the members of the faculty.

- Quality and adequacy of research infrastructure and support.

There is a respectable number of high quality equipment available to the researchers. It includes environmental scanning electron microscope (SEM), scanning tunnelling microscope (STM), atomic force microscope (AFM), a range of high quality optical equipment and a small size clean-room facility. However some basic equipment is lacking such as a state of the art X-ray powder diffractometer and magnetometer. The faculty has spent a huge amount of time and effort to install and maintain the equipment despite the small amount of support and funding from the University (especially when compared with more traditional and historic Departments).

#### **Recommendation**

The University should increase the percentage of funding allocated to the Department or support the Department's efforts to acquire or upgrade research equipment.

- Scientific publications.

Based on the internationally recognised Web of Science data, the Department has demonstrated a good number of publications and citations year after year for the period 2007-2011. For the period 2001-2013 (up to 31/8), the Department has produced a cumulative number of 600 publications and more than 10000 citations, which is quite impressive given the small number of staff and the limited laboratory space and resources. The Department research groups have a large number of young and dynamic researchers with substantial visibility and recognition in the international research community as conferences invited speakers, visiting professors, scientific journal editors, and consultants to international organisations.

- Research projects.

Due to the small size of the department there is no formal grouping between the various research activities. From the technical presentations to the EEC during the visit, however, it was apparent that the staff collaborates extremely well and the research conducted currently can be divided in the following broad research topics:

- Functional nanostructured & hybrid materials
- Biosensors and Biomaterials
- Computational Materials Science
- Photonic, Electronic and Energy related research in the MSD
- Molecular Materials Properties
- Magnetic Nanomaterials

Each category involves a large number of staff with varying seniority and experience with some participating in more than one topic. This congenial collaboration ensures good synergy and cross-pollination between the various research topics. This openness and amiable atmosphere lies at the heart of successful groups and should be maintained and strengthened even further.

Recommendations:

1) This close interaction between the various research groups should be further encouraged and strengthened in order to increase the research outcome and funding opportunities. The culture of collaboration should be extended to other Material Science and related Departments in other Universities.

2) The computational materials science group is strong, productive and their work results in high impact publications. To further strengthen its impact, attempts should be made to work closer and provide theoretical support to the other experimental groups of the department

There is a very strong experimental and theoretical activity in the modern directions of nanomaterials and photonics. The nanomaterials activity involves research in nanostructured and hybrid materials including functional colloidal nanoassemblies for biomedical applications, low dimensional hybrid organic/inorganic semiconductor materials, biocompatible quantum dots. In addition, there are multiple strands of research on the

synthesis, characterization and development of functional carbon-based nanomaterials and nanohybrids. This involves different novel isolation techniques of graphene (isolation of graphene from graphite or chemical exfoliation by oxidation/reduction protocols) and the study of its physical, chemical and mechanical properties in different structures. The work also studies organic inorganic hybrid materials and perovskite type systems as well as the properties of carbon nanotubes in meltable or silicone functionalized materials. The strategic importance that the Department places on the fast growing and technologically important area of carbon-based nanomaterials is emphasized by the additional (the latest) appointment of an experienced Assistant Professor. The work on carbon based nanomaterials involves also strong collaborations with other Universities and Research Centers in Greece and Abroad.

Photonics plays such an important, enabling role in advanced manufacturing, communications and information technology, defense and national security, energy and health and medicine that the US Government, following similar initiatives in Europe and Asia, launched in 2013 a National Photonics Initiative (NPI) to identify and further advance areas of photonics critical to regaining US competitiveness and maintaining national security. The Department research activity in Photonics is very strong and encompasses fundamental research on versatile laser microfabrication techniques, such as direct laser writing and microfabrication, direct laser and soft lithography, and pulsed laser deposition for advanced photonic structures. Also the research involves techniques using optical radiation forces for soft matter organization and microstructuring. Finally, the work concentrates on the study and development of practical remote optical sensors, photoluminescent materials etc.

The experimental photonics activities are complimented by very strong and extensive theoretical studies of a wide spectrum of photonic micro- and nanostructures. These involve quantum theory of optical and electronic properties of photonic materials, such as coherent control and quantum interference effects and enhanced nonlinear properties in semiconductor nanostructures. These also involve the study of phononic and photonic materials, such as photonic bandgap materials and multilayer photonic structures for temperature sensing, and modeling of nanostructured materials, such as graphene based materials and Mg nanoclusters/nanocrystals for efficient hydrogen storage.

Some of the presented projects were collaborative work between different faculty members from experimental and theoretical groups. This is a highly commendable fact and should be encouraged and promoted further to include more staff, especially the more junior ones

#### *Recommendation*

*Given the strengths and complementary skills of experimental and theoretical groups their collaboration should be further strengthened and extended to involve more staff and other research activities.*

#### RESULTS

- How successfully were the Department's research objectives implemented?

The research objectives of the Department were clearly articulated and over the years well implemented. The three major scientific directions (Microphase and nanophase materials, Molecular materials, Biomaterials) were chosen to be broad enough to be inclusive yet, specific enough to point to coherent directions for the department and to guide the recruiting

of faculty members. These scientific directions are topical, relevant, non-traditional and important to current trends in Materials Science.

**Recommendation:**

The Department should keep the major scientific directions broad in order to be agile and flexible to stay relevant and respond quickly to future developments in the field of Materials Science.

- Scientific publications, Research projects, Research collaborations.

The number and level of scientific publications were very good. The EEC was also pleased to see that faculty members leverage both the limited local scientific facilities and resources as well as those of outside collaborators to accomplish significant publications in excellent international journals.

**Recommendation:**

- 1) The Department should further encourage the pursuit of high quality publications
- 2) The Department should encourage internal and external collaborations that lead to high levels of synergy
- 3) The Department should make it a goal to produce a rising level of publications each year
- 4) The Department should cultivate a strong culture of aggressively pursuing research funding from as many outside sources as possible. Overtime, rewards should be implemented by the University and the Department for those who win external funding

- Efficacy of research work. Applied results. Patents etc.

An example that stood out during the presentations demonstrating efficacy and impact of the research work was the collaboration between the Department's Photonics and Biomaterials groups for the development of novel technique for effective and painless sialoliths removal using a Holmium doped pulsed laser emitting at 2microns. The technique is developed as part of a PhD research program with a medical staff of the Hellenic Air-Force Hospital, since the technique results in minimum intrusion without any of the detrimental side-effects of currently used techniques (permanent disorientation and inability to fly) on Air-Force pilots.

The nature of the research carried out in the Department is definitely patentable and the research staff should be encouraged to consider patenting novel results and ideas. The number of patents/patent applications can well be one of the metrics considered for internal promotions. Currently, there is a very low level of invention disclosure and patent activity. However, it should be realized that patent filing and support is a time consuming and expensive activity and a top level University-wide clear strategy should be formulated. Also appropriate levels of legal support is needed.

- Is the Department's research acknowledged and visible outside the Department?  
Rewards and awards.

Trends in citations and other objective metrics of success in scholarly activities indicate that the visibility of the department is increasing fast. If some of the above recommendations are heeded in the long term the visibility and recognition of the Department will be significantly

enhanced.

#### IMPROVEMENT

- Improvements in research proposed by the Department, if necessary.
- Initiatives in this direction undertaken by the Department.

Please see recommendations regarding lack of space and burgeoning bureaucracy elsewhere in this document. Do something!

#### Recommendation:

The Department lacks some basic fundamental materials characterization equipment. For example, the Department should make it a priority to acquire an X-ray powder diffractometer. A magnetometer and basic variable temperature charge transport measurement equipment may be other examples.

The Department stands to benefit significantly from outside know-how, expertise and good practices from leading international Departments of Materials Science, Chemistry, Physics, Biology, etc. The recommendation below is intended to boost the level of scientific quality, faculty confidence, faculty ambition and at the same time increase Department awareness and visibility elsewhere. Developing stronger international links will make the UoP and the Department better known to these top laboratories. New knowledge at all levels of good practices in well-known successful Departments can be emulated locally and in the long run will bring tangible improvements in running the Department.

#### Recommendation:

- 1) Faculty members of the Department should pay attention to “extroversion”. Extended visits to top-rated laboratories around the world will broaden horizons, enhance know-how, strengthen or create new scientific directions, establish productive collaborations and create a better perspective of how excellent institutions operate. Sabbatical leaves and externally funded fellowships could be used for this purpose.
- 2) UoP should establish mechanisms through which external scientists from abroad, foreign graduate students, and top-notch renowned scientists can visit the Department over a period of time through Fellowships, visiting professorships, studentships, joint research grants etc.

### **D. All Other Services**

*For each particular matter, please distinguish between under- and post-graduate level, if necessary.*

#### **D1. APPROACH**

##### University services to students

UoP does what most other Greek institutions of higher education do to support students and ensure that they have a reasonable quality of life during their years with the University.

##### University services to the Department

The committee did not have the opportunity to probe those at any serious depth. Main reason was time limitations.

#### Services within the Department

The department, within its limited resources does its best to provide good computational and research infrastructure services for students, staff and faculty. Further, secretarial support appears to be maintained at good levels, primarily thanks to the efficient of a few key personnel.

The Department is seriously understaffed relative to the number of students it must process annually.

Secretarial support seems adequate (7 active persons) but performance across these persons varies significantly. Workload and performance was said to be unevenly distributed where a few carry a disproportionate load while others underperform. As a result, the few staff that carry most of the load are overworked and this is compounded by bureaucracy and the fact that electronic processing is low. Because of the very limited space a high traffic of students often distracts the secretarial staff that further add to the smooth execution of their duties.

Some of the staff are well trained and qualified to cover the needs of the Department but relief needs to be provided on the work load by adopting more flexible staffing procedures where more nonpermanent staff can be hired on an as-needed basis to supplement the existing staff. In the past, valued and highly competent secretarial staff has been moved to other University positions by the University away from the Department, but care was not taken to find suitable replacements, leaving productivity-crippling vacancies behind.

- Does the Department have a policy to simplify administrative procedures? Are most procedures processed electronically?

No. The EEC was told of a belated University initiative (ψηφιακο άλμα) aimed to go “all electronic”, but currently most procedures are not processed electronically. This problem needs to be addressed as soon as possible by accelerating the implementation of this University initiative. It is hoped that this modern productivity-enhancing tool will provide significant relief on current workloads for those who now execute these procedures.

#### Recommendations:

- 1) Good secretarial support is crucial to a well-functioning department. Non-performing staff should be given opportunities to improve, lest they be demoted or removed from the Department.

## **D2. IMPLEMENTATION**

#### University services to students

The committee acknowledges services offered by the University to the students. These include: library services and resources; student housing and free food (board) services for those who qualify; medical insurance; and discounted public transportation.

#### University services to the Department

The committee did not have the opportunity to directly probe these services.

#### Services within the Department

The EEC received positive comments from students and staff regarding the high quality services provided by the computer specialists and technicians in the Department. Further, three secretarial staff are highly qualified (two with advanced Physical Sciences degree and one with Business Management degree holders) and very efficient in handling a wide range of duties. Further, a secretarial staff with a BS in Math and an MS in Education is currently on maternity leave.

### **D3. RESULTS**

The committee did not have an opportunity to assess central UoP administrative services.

Secretarial support of various kinds is of crucial importance for the smooth operation of any academic unit with many factors involved. Currently, there is a considerable number of staff serving the secretariat of the Department. However, for a variety of reasons, there is an uneven distribution of workload among these staff, leading to overwork for some of these individuals.

### **RECOMMENDATIONS**

1. UoP is moving towards an automated system for student enrollment in various classes (“digital jump”). This is a long-overdue practice followed in almost every single European/US higher education institution, which should increase the speed and quality of services to students, centralize a key and repeated university function and increase productivity of the secretarial staff for the Department, thereby allowing the same staff to perform other needed duties.
2. A more direct and efficient communication channel needs to be established between faculty and UoP-level officials. Personnel identifying funding opportunities and bringing those to faculty attention could increase the competitiveness of UoP faculty to win competitive grants.
3. Establishing a competent pre-award office within the Department or at the School of Natural Sciences level should also increase winning competitive grants, but having these offices handle proposal red-tape, and leaving time to the scientists to focus on the research component of the proposals.
4. Establishing a reward system (monetary bonus or simply awards) to reward efficient personnel would motivate increased quality of service at all levels, including secretarial support.
5. Establishing an organizational chart for the secretary and staff of the Department office will help streamline functions and duties among staff more equitably.

### **Collaboration with social, cultural and production organizations**

Please, comment on quality, originality and significance of the Department’s initiatives.

The department participates each year into a wider UoP open day initiative (“Τα Σχολεία πάνε Πανεπιστήμιο”) aiming at opening up the University to schools. Groups of pupils attend a short introduction to Material Science followed by an open discussion and a tour to the Department’s labs and other facilities. This is an extremely important initiative, which facilitates the familiarization of pupils with Material Science at an early stage. It also raises the Department’s profile and increases awareness among talented kids who are the next potential generation of undergraduates. Also, the Department has produced a single-page flyer, which is sent to high schools in the area, explaining the role of Materials Science in modern society and industry and aiming at increasing young students’ awareness.

The relatively low average grade achieved at the University entry exam by the 1<sup>st</sup> year students entering the Department is one of the serious impediments on subsequent teaching. Thus, these initiatives are extremely important and highly commented.

In collaboration with the other two Materials Science Departments in Crete and Ioannina, the Department participates in a newly established program of “Life-long Education” (2013-2015) offering the possibility to a wider audience to familiarize themselves with the latest developments in Material Sciences for Advanced Technologies.

*Recommendation:*

*The recommendation is to further enhance these activities for example by:*

- 1. During the “Τα Σχολεία πάνε Πανεπιστήμιο” open day to include simple hands-on demonstrations for pupils to try and get a more immediate and vivid experience.*
- 2. In collaboration with the other Materials Science Departments to start a wider nation-wide initiative where short lectures and presentations, promoting the significance and impact of Materials Science and Engineering in modern society and industry, are delivered in selected high schools. Such an initiative can increase significantly the pool of nation-wide high quality potential undergraduates who will **choose** to follow Materials Science and Engineering in their undergraduate studies.*

The Department encouraged and supported the establishment of the Greek Society of Materials Science and Technology (EAEETY) in 2007 by the Department’s Alumni in order to elevate and professional status and to promote the professional rights of all the Materials Science Departments graduates. Due to severe financial difficulties the Society is currently idle.

Collaboration with industry is achieved via the optional student practical course, which is included in the fourth year of the undergraduate curriculum. This program aims to align the Department activities with industry’s needs, broaden of students’ horizon and experiences on a practical level and strengthen the links between academia and industry. A large number of Greek Industries in the area of Patras participated successfully in the program. A number of industrial visits by students in selected industries is also organized to promote links and better understand the industrial needs.

The department so far has also organised 6 colloquia on “Materials Science and Industry” with participation of a wide range of industry such as Χαλυβουργική ΑΕ, Αλουμινιον ΑΕ, TITAN ΑΕ, ΑΒΕΞ ΑΕ, ΒΙΕΜΕΤΑΛ ΠΑΝΕΛ ΑΕ, Solar Cells Hellas ΑΕ, Prime Laser Technology ΑΒΕΕ, Optronics Technologies ΑΕ, Megaplast ΑΕ. Due to lack of funding, this

extremely important initiative is currently suspended. Due to University Central Administration delays and inactivity, an opportunity to fund this initiative for another five years was missed.

Finally the innovative work of key academic and research staff has been featured and widely advertised in the local and national press, further increasing the profile of the Department.

### ***E. Strategic Planning, Perspectives for Improvement and Dealing with Potential Inhibiting Factors***

*For each particular matter, please distinguish between under- and post-graduate level, if necessary.*

Please, comment on the Department's:

- Potential inhibiting factors at State, Institutional and Departmental level, and proposals on ways to overcome them.

The Department is young (just over a decade old) but has already, and to the credit of the founding members and those who came after them, is trying hard to establish a permanent culture of excellence. To a good extent they are achieving it. This is very positive. They are commended and are urged to continue to do so.

The overall quality of the scientific research pursued by the faculty is high. The research output and quality of the publications is high and rising. The EEC was impressed with what was accomplished with the minimal resources given to the Department and the faculty. This is mainly due to the individuals making up its faculty who come from a diverse set of scientific backgrounds.

Faculty of the Department have succeeded in attracting a respectable number of external grants including large highly competitive grants such as European ERC and ICT and ΘΑΛΗΣ projects. The Department should make it a goal to achieve every year a higher number of publications than the year before. To the Department's credit the EEC detected no pattern of nepotism-related faculty hiring. This pattern must continue.

From the very beginning of the evaluation process it became immediately apparent to the EEC that there are enormous barriers to the smooth functioning of the Department. The barriers originate from the existing maze of rules and regulations and laws of the Greek state that inhibit most aspects of day to day operations. These range from teaching, administration and the execution of research. Simple and routine operations such as ordering, receiving and paying for items needed for performing work become a huge waste of time and an exercise in the successful navigation of the bureaucracy and the running from one place to the next collecting signatures. By the time these processes are finished one is exhausted and discouraged. The unreasonable rules of bureaucracy (regulations have dramatically increased in recent years) are now major obstacles to productivity. This time will be better used supervising/advising students, writing of proposals and research papers and performing research.

Based on anecdotal accounts of what it takes to order routine items, the EEC was appalled to learn of this incredible level of bureaucracy. The EEC learnt that various types of expenses are divided in a very large variety of categories and codes. There is an impenetrable wall between the codes.

This rigidity and plethora of codes/categories often lead to errors or dead-ends where funds available in one category of expense code cannot be used to purchase needed items in another. In those rare cases they can be used, University personnel are not helpful. In one case the EEC learnt that 1000 euros allocated to a newly hired faculty member for acquiring office furniture, he did not need, could not be converted to a category where they could be used to purchase more needed items for his research. In this case the EEC was told that the University could have allowed the conversion but chose not to. Clearly, this an example of unwise and unnecessary expenditure of precious scarce funds. One way much of this problem may be speeded up and simplified is if it were possible to use Departmental credit cards using appropriate oversight. This is a standard practice in many major US universities. There are other ways that can be used and the University Administration and Greek State need to engage in creative thinking to find them. Clearly, the current process is not working and the system suffers from what we call “unacceptably high levels of process viscosity”.

This situation places the faculty at a huge competitive disadvantage compared to peers in other leading institutions in advanced countries. The EEC believes that a vast fraction of the problem/challenge in raising the quality of the Department at most levels derives from inefficiencies resulting from Greek law. Thus, the EEC believes that a higher level of performance can be reached quickly upon a significant reduction of the bureaucracy.

The excessive number of undergraduate students the Department is forced to admit by the Greek State is also a cause of inhibition of the Department’s role and mission. The Department was created to educate about 50 undergraduates per year but this number has now ballooned to nearly 130 per year. In other words, the Department is forced to accommodate anywhere from 100-200% excess students above its capacity. In addition, many of the admitted students lack the necessary background to begin studies in Materials Science. Many lack the necessary motivation to fully embrace the subject and succeed. This overloads all aspects of the operation of the Department and consumes the scarce time and material resources, thereby lowering the quality of education. Compounding this chronic problem is the existence of so-called “eternal students” who must be dealt effectively because it further drains energy and resources.

Other important issues: A) the total lack of startup fund packages for newly hired faculty. B) absence of incentives to improve performance, productivity and excel in teaching and research. C) absence of stable funding environment from the Greek State with predictable and recurring funding cycles. D) the total exclusion of the department from allocation of funds from ESPA for more than 5 years now. This is a major problem for a well-performing Department, which simply does not get its fair share of resources by the University administration. UoP has to revise its antiquated formula for allocation of resources to its various units/departments towards a more transparent system, which should be merit-based alone.

**Recommendation:**

- 1) The rules and regulations and laws of the Greek state are beyond the control of those in the Department and University. These regulations need to be reconsidered, simplified and reduced in order to allow a more efficient operation of the Department’s duties and execution of its mission.

- 2) To the extent this depends on the university, regulations need to be much more flexible and simplified than they are now.
- 3) The Greek state must get out of the business of deciding how many students are admitted to the Universities and the individual Departments. This decision needs be left to the Universities and the Departments.
- 4) Implement the use of startup fund packages for newly hired faculty with associated freedom given to the faculty to spend as they see fit.
- 5) Implement the concept of unequal distribution of resource allocation based on merit and performance. Set clear Departmental and University guidelines defining what “excellent performance” is.
- 6) The Greek state must create a stable funding environment with predictable and recurring funding cycles. Criteria for funding must be based on excellence.
- 7) Establish incentives aimed at developing a culture of achievement. Rewards such as increased resources, increased support, reduced teaching load, even monetary incentives for highly achieving faculty members (e.g. publication of very high profile papers, winning large grant competitions) should be implemented.

The EEC learnt of a chronic and divisive situation existing in the Department where past disagreements between some faculty members have created a charged and antagonistic atmosphere which if it continues has the potential to seriously harm the progress of the Department. When such a situation exists, a sense of insecurity and low morale can be shown among the young faculty who may feel obliged to choose sides. The EEC urges all members of the Department to pay attention and take great care in order not derail its current course. A sustained collegial atmosphere characterized by mutual respect, mutual support and willingness to compromise is a key pillar of a strong Department. The Department is strongly encouraged to continue efforts for a consensus culture and reassure young faculty of meritorious and objective treatment. Great Departments have been created by a sustained culture of excellence in research, teaching as well as collegiality.

During the first day of the visit the EEC was told by the Administration (Rector) that the Department is one of the top 4 Departments in the University. After subsequent meeting and presentations of data, the EEC, however, has the sense that the Department does not enjoy the full support of the University administration. Anecdotal reports informed the EEC that the Department may have been systematically discriminated against in various ways, especially since 2006. No explanation for this was given. The reports indicated that the Department has received minimal support since 2006 and it may have been excluded from opportunities to compete for funding at the regional level (Περιφέρεια, ESPA funds, etc). The reports also indicated that the Department may have been systematically excluded from some forms of support by the University, without proper justification, while such support was provided to other Departments. Complaints were expressed of disproportionate allocation of resources to the Department relative to other Departments.

Recommendation:

- 1) The University should increase its support of the department in a way that is commensurate with its assessment that it is one of the top departments in campus.
- 2) The University must act as a catalyst to enable the Department to perform its academic mission without unnecessary intrusions.
- 3) The current “algorithm” used by UoP to make allocations of resources to various Departments should be revisited and reviewed with an eye of making corrections and updates to better reflect the present situation of Departmental needs. Changes to the “algorithm” should be made periodically (e.g. every 4-5 years) to keep it relevant to the university dynamics and needs.

A huge factor inhibiting the Department is the lack of adequate space. Both in quantity and in quality. The Department is compressed in a small complex of outdated buildings. The teaching and research space is very small. The teaching and research space appears to be too close to one another (in some instances being one and the same) or significantly entangled creating problems. The present space cannot accommodate the very large number of students admitted and this has an impact on quality. The room available for expansion of research groups or for the placement of advanced instrumentation is negligible. The creation of new modern space for the Department must be a high priority for the University. While the EEC recognizes the current dire financial situation of the Greek State (the historical source of funding for new university buildings), creative new ways must be sought to find new space.

Recommendations:

- 3) A mentoring system should be established to help new faculty navigate the maze of regulations, protect from departmental politics and maximize their performance and chances of a successful career. In such a system more senior colleagues with a record of excellence in research and a high collegial spirit will act as mentors.
- 4) The Lecturer position is now abolished. The EEC recommends the remaining Lecturers be promoted to assistant professors with full rights as all faculty members. This will also contribute to higher morale.

The EEC was impressed by the high level of competence exhibited by the technical staff. When it comes to technical staff the Department is significantly understaffed. As a result, the faculty spends too much time doing tasks that should be done by technical staff.

- Long-term

The EEC detected a good level of team spirit in the vast majority of the Department with a few exceptions. Many faculty appear to work well together and this is also supported by the number of publications with joint authorship. The EEC encourages the promotion of a team-spirit culture and urges the Department to further strive to increase it in the future. Current trends in science and in science funding encourage the creation and development of highly effective multidisciplinary teams (both Intra- and extra-departmental) that can work on big challenging problems. A highly developed team culture enhances the chances of success both in achieving excellent publications and winning large grants from funding agencies. When it comes to performing high level research with external funding, a small Department such as

this stands to benefit from a healthy “we are all in this together mentality”.

### **Some additional comments**

#### **A. The present**

The three Materials Science departments in Greece (Crete, Ioannina, Patras) have faculty members of high quality with impressive research and teaching performance. They have produced graduates who are performing efficiently in their further doctoral studies in several departments and universities both in and outside Greece. (EEC members had some firsthand experience by interviewing PhD students and their professors).

To date, the Bachelors degree graduates who reach the Ph.D. level are less than the 10% of the total number of graduates. What happens with the other 90% of the graduates? This is unknown because both the universities and the dormant “Association of Material Science Graduates” do not appear to keep records. These graduates and the faculty members have no clear picture of where and how to look for the potential of employers. The same holds for the University’s administration which should be involved in this area.

EEC member Alexis Stassinopoulos is affiliated with manufacturing companies which could be “potential employers” of material science graduates at all levels. He has discussed this matter with several high and middle level technology managers responsible for hiring of engineers and physical scientists. Their general opinion is that:

- The material scientists and engineers graduating from materials science departments are not directly visible to them.
- They do not see a compelling advantage of hiring a material science graduate.
- They perceive that one could not be a “specialist” in every material by just having taken the corresponding university courses. The Department should be aware of this and increase its efforts to convince potential employers that its graduates have the basic university training and thus the capacity of continuous on the job training

#### **The Future**

Here are some personal comments on how the departments of materials science would not only be “centers of research excellence” but would extend their usefulness to the professional survival and advancement of the non-Ph.D. graduates, which are the approximately 90% of the total number of graduates:

- The materials science departments should optimize their resources by focusing on their strong assets.
- Their main priority should be the offering of post graduate training (Master, and Ph.D. degrees). They could also offer non degree specialization courses with the corresponding certification).
- The post-graduate candidates could come from all the departments of engineering and physical sciences. In this regard they would need the close interaction with these other departments. There are several ways to cultivate these interactions. One of them could be if the operating university unit is the School (Σχολή) and not the Department (Τμήμα).

### ***F. Final Conclusions and recommendations of the EEC***

Conclusions and recommendations of the EEC on:

- the development of the Department to this date and its present situation, including explicit comments on good practices and weaknesses identified through the External Evaluation process and recommendations for improvement
  - the Department's readiness and capability to change/improve
  - the Department's quality assurance.
1. The number of admitted students per year should be decreased to 50.
  2. An effort should be made to improve the quality of admitted students by accepting students with the proper background. For example, it is entirely unacceptable to allow entering students with no or very weak background in Chemistry, Mathematics or Physics.
  3. A number of pre-requisite courses in compulsory courses should be introduced. This will help to shorten the time to degree.
  4. Homework assignments to the students should be increased significantly and mid-term exams should be established in all courses.
  5. The introduction of new material in courses related to the synthesis, characterization, and process technology regarding several materials used and manufactured by the Greek industry.
  6. The number of ECTS related to Chemistry courses in nature, and in particular to those dealing with the synthesis of materials used in important technological applications, should be increased.
  7. The instructional labs should be often upgraded with modern instrumentation and all the instruments should be properly maintained. Funding should be provided for both activities.
  8. The Diploma Thesis should be made as a mandatory course when the number of admitted students is such that every faculty is able to supervise 3-4 students.
  9. The EEC feels that compared to top programs in Europe and the USA, the curriculum is somewhat excessive in the number of courses, both mandatory and electives. The number of courses that students take should be reduced in order to allow more in-depth coverage and better retention of the information. This will require a careful consideration in order to meet the required ECTS (240) by University rules.
  10. A professional MSc degree in Materials Science (with tuition fees) could be developed to meet the main current needs of the Greek industry. This could result in significant revenues for the further development of research within the Department.
  11. An effort should be made by the University to substantially increase the number of scholarships allocated to the Department according to its excellence in research.
  12. The stipend support should include teaching duties for the running of the undergraduate laboratories. This will alleviate the shortage in ETEΠ personnel.
  13. The Department, with the help of the University, should make extra efforts to recruit high quality undergraduate students - via better advertisement, offering fellowships and other special incentives.
  14. Assuming that some financial resources to pay for travel expenses and honoraria for the seminar speakers is guaranteed, a regular, Departmental seminar series should

be implemented to meet the needs of both the MSc and PhD programs..

15. The EEC feels that the Department should strengthen the informal scientific interactions among students, faculty and staff of the research groups within the Department. This could include joint group meetings, cross-group journal clubs, an internal seminar series, whereby MSc and PhD students present their research on a rotating basis, and an annual poster symposium with awards.
16. The Department should encourage the participation of students in national and international conferences.
17. Efforts should be made to facilitate the enrollment of foreign students to the graduate programs (use of English language, formalize PhD dissertations in English).
18. The quality of training and time to graduation can both be improved by drastically decreasing the number of students admitted to the program. This will also raise the average quality of incoming students.
19. Faculty should launch a systematic effort to increase attendance of lectures and student engagement in learning during the entire academic year, by encouraging participation in homework assignments and by establishing mandatory midterm exams. Both elements could enhance the learning experience. As currently practiced, stand-alone studying by the students near the end of the semester only, does not foster active student-faculty scientific exchange spread over the entire semester.
20. Funds need to be secured urgently for re-invigorating the practical training experience in industry, which gives students a great idea of what they are going to be doing during their careers in a typical Greek industry.
21. More resources need to be secured, so that more students of the Department can participate in the ERASMUS exchange and the ERASMUS Placement programs. This is a fantastic opportunity for the students to not only experience how learning is pursued in different industrially advanced nations, but also exposes them to different cultures and general attitudes of life in other European countries; an experience with transforming potential for young individuals.
22. To become more competitive on a global scale, teaching load of individual faculty needs to be decreased, so that time can be saved and used towards research related activities, which in turn can further enhance the visibility and recognition of the department in their peer community and eventually reflected in the international disciplinary rankings.
23. To increase the influx of ERASMUS students to the department, the faculty may wish to consider teaching a set of advanced optional courses in English.
24. Efforts should be made so that students get access to their textbooks earlier in the semester than currently practiced.
25. Faculty noted that there are no major pre-requisites for more advanced core courses. Although this may be practical for most cases, the committee feels that this general policy may need to be re-evaluated for a more natural progression of students through the well-thought curriculum already set in place.
26. Consider to deliver the MSc course in English to increase the pool of high quality students, increase the international status of the Department and the University at large. Introduction of moderate amount of fees and use this income to improve experimental facilities or support students in need.
27. Improve the quality of building and teaching facility infrastructure in order to increase the profile of the MSc course and attract larger number of students.

28. Constantly revise the content of the teaching techniques of the MSc program in order to keep the student's interest and enthusiasm to high levels.
29. Consider liaising with other institutions in Greece or abroad in order to increase the exposure of the MSc student to a larger variety of practices and scientific culture.
30. Increase the role of and seek more advice from industry in updating the MSc curriculum and the required skills.
31. The Department should further encourage the pursuit of high quality publications
32. The Department should encourage internal and external collaborations that lead to high levels of synergy
33. The Department should make it a goal to produce a rising level of publications each year
34. The Department should cultivate a strong culture of aggressively pursuing research funding from as many outside sources as possible. Overtime rewards should be implemented by the University and the Department for those who win external funding
35. Faculty members of the Department should pay attention to "extroversion". Extended visits to top-rated laboratories around the world will broaden horizons, enhance know-how, strengthen or create new scientific directions, establish productive collaborations and create a better perspective of how excellent institutions operate. Sabbatical leaves and externally funded fellowships could be used for this purpose..
36. UoP should establish mechanisms through which external scientists from abroad, foreign graduate students, and top-notch renowned scientists can visit the Department over a period of time through Fellowships, visiting professorships, studentships, joint research grants etc.
37. Good secretarial support is crucial to a well-functioning department. Non-performing staff should be given opportunities to improve, lest they be demoted or removed from the Department.
38. UoP is moving towards an automated system for student enrollment in various classes ("digital jump"). This is a long-overdue practice followed in almost every single European/US higher education institution, which should increase the speeded and quality of services to students, centralize a key and repeated university function and increase productivity of the secretarial staff for the Department, thereby allowing the same staff to perform other needed duties.
39. A more direct and efficient communication channel needs to be established between faculty and UoP-level officials. Personnel identifying funding opportunities and bringing those to faculty attention could increase the competitiveness of UoP faculty to win competitive grants.
40. Establishing a competent pre-award office within the Department or at the School of Natural Sciences level should also increase winning competitive grants, but having these offices handle proposal red-tape, and leaving time to the scientists to focus on the research component of the proposals.
41. Establishing a reward system (monetary bonus or simply awards) to reward efficient personnel would motivate increased quality of service at all levels, including secretarial support.
42. Establishing an organizational chart for the secretary and staff of the Department office will help streamline functions and duties among staff more equitably.
43. The rules and regulations and laws of the Greek state are beyond the control of those in the Department and University. These regulations need to be reconsidered,

simplified and reduced in order to allow a more efficient operation of the Department's duties and execution of its mission.

44. To the extent this depends on the university, regulations need to be much more flexible and simplified than they are now.
45. The Greek state must get out of the business of deciding how many students are admitted to the Universities and the Department. This decision needs be left to the Universities and the Department.
46. Implement the use of startup packages for newly hired faculty with associated freedom given to the faculty to spend as they see fit.
47. Implement the concept of unequal distribution of resource allocation based on merit and performance. Set clear Departmental and University guidelines defining what "excellent performance" is.
48. The Greek state must create a stable funding environment with predictable and recurring funding cycles. Criteria for funding must be based on excellence.
49. Establish incentives aimed at developing a culture of achievement. Rewards such as increased resources, increased support, reduced teaching load, even monetary incentives for highly achieving faculty members (e.g. publication of very high profile papers, winning large grant competitions) should be implemented.
50. The University should increase its support of the department in a way that is commensurate with its assessment that it is one of the top on campus.
51. The University must act as a catalyst to enable the Department to perform its academic mission without unnecessary intrusions.
52. Encourage graduate students to publish and/or participate in conferences.
53. The current "algorithm" used to make allocations of resources to various Departments should be revisited and reviewed with an eye of making corrections and updates to better reflect the present situation of Departmental needs. Changes to the "algorithm" should be made periodically (e.g. every 4-5 years) to keep it relevant changes in the university.
54. The Department should start an alumni database to the best of its ability. This database should be kept current to the best of the Department's ability. Such a data base can help keep track of alumni and serve as a mailing list for sending departmental letters with news and developments happening in the Department. This database should be kept in perpetuity.
55. The Department has a duty to take care of its young faculty, support them, and groom them to the best of its ability for success. The nurturing culture if developed strongly in the Department will set the foundation for continued success.
56. The Department should continue its practice of hiring new faculty with significant research, PhD or postdoctoral experience abroad.

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