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EVALUATION

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Evaluation of the Danish Polymer Centre

Danish Technical Research Council

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Danish Technical Research Council/
Technical University of Denmark

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Frontpage, top: AFM topography micrographs of
(A) a fibrillar collagen coated silicon wafer, (B) a
nickel die negativ of the fibrillar collagen and
injection molded replicas in (C) poly(ethylene)
and (D) poly(propylene).

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I. INTRODUCTION

The Danish Polymer Centre (DPC, www.polymers.dk) was formed in 1999, primarily as a merger of polymer research groups at Risø National Laboratory (Risø) near Roskilde (www.risoe.dk) and the Technical University of Denmark in Lyngby, north of Copenhagen (www.dtu.dk). The distance between the two partners is about 40 kilometres. Special funding was provided, primarily by the Danish Technical Research Council (STVF), according to an agreement between the two parent institutions, STVF, and Danish industry. This funding was provided for a four year period (1999-2003); possible continued support may be considered by STVF. During the first years after the merger both Risø and DTU went through considerable structural changes which, among others, led to a decision to change the statutes of DPC. These changes are presently in the process of being completed.

The stated remit of the Danish Polymer Centre is:

”To achieve considerable, long-term reinforcement of Danish polymer research and to further the use of polymers in industry. The Centre will also form the basis for education at researcher, post-graduate and diploma levels in the area of polymers.”

In order to facilitate decision-making on the future policy regarding DPC, STVF concluded that a ”3/4-term” evaluation would be useful. This task, defined in the Terms of Reference (Annex 1) was given to an International Panel (Annex 2). The Panel was, in particular, asked to evaluate the outcome of DPC activities up to August 2002 and to consider its potential for future development. The resulting report includes the Panel’s opinions on the relevance and quality of the research, the dissemination of R & D results, DPC contributions to scientific training activities, and an assessment of the planning for the future of DPC. These observations by the Panel are primarily based on a full day’s visit at DPC (Annex 3), discussions with key persons (Annex 3), and written material received from DPC (especially Annex 4).

II. EXECUTIVE SUMMARY

The Panel was impressed by the generally high standard of research at the Danish Polymer Centre and found that the creation of DPC has played a positive role in the promotion of polymer science in Denmark. There is much to be commended in terms of the progress made within several of the individual DPC research areas since the start of the Centre. Training is also a very important activity at DPC and it is fully integrated with the research. Recruitment of qualified, graduate students may become a problem in the future and present plans for establishment of an International Masters program are strongly supported by the Panel.

Despite a still incomplete integration between the polymer activities at the two parent institutions, Risø and DTU, a delay partly caused by recent, extensive structural changes in these two institutions, DPC has made progress towards the formation of an identifiable polymer resource centre. The Panel finds it important that the new agreement with Risø and DTU (the new statutes) promote a more homogeneous future development of the DPC - its future success depends critically on the creation of an effective, integrated management structure, and a clear and precise definition of the directions for its future development. Not only the new management, but also the DPC Board has an important role to play in this connection.

The strategic importance of polymeric materials, in both economic and technological developments, necessitates that Denmark should have a resource centre in polymer research, and the Panel supports the development of the DPC as such a focal point for polymer science. In order to fulfil this role in the coming years, DPC must further intensify its co-operation with industry. In addition, it must, primarily through increased industrial and international co-operation, start preparing for a future without the present special support from STVF. However, the Panel believes that the progress made during the last few years warrants a continuation of the funding to the Centre to its next state of development, and recommends that the support is continued beyond the present four year period.

III. OBSERVATIONS

In the following, the Panel will comment, in particular, on the following specific issues:

- The extent and scientific quality of DPC research, its international position and impact, compared with similar research groups in other countries
- The structure and organisation of research and training at DPC

III.1 Research Activities at DPC

The Panel was impressed by the high standards of research carried out in several of the DPC groups. As described in Annex 3, the Panel visited DPC laboratories, heard formal presentations by several DPC research groups, including associate groups at other Danish universities, had discussions with the acting Director and Deputy Director of DPC, and was provided with written documentation, primarily DPC annual reports and a self-assessment (Annex 4) from DPC (the self-assessment originally received was later improved and expanded according to a request by the Panel). Based on this, the Panel was able to obtain a clear, overall picture of the quality standards and work procedures of DPC. Considerable investments in infrastructure, good laboratories with high quality equipment, and, in general, the creation of a good work environment have taken place since the establishment of DPC, and the outcome of these illustrate the capabilities of the Centre. Among the fields in which the DPC activities impressed the Panel were:

- Rheology - both modelling and experiments. These activities are directly relevant in connection with one of the major aims of DPC - to support the Danish Polymer Industry. The groups are involved in technologically very relevant and academically challenging research.
- Work on the spectroscopic monitoring of oxygen in polymer films - which is of direct technological relevance to areas such as packaging and electronics, for example in connection with the degradation of polymeric materials.
- Polymers for use in solar energy systems.

- Biomimicking polymer surfaces for use in medical applications, for example as aids to surgical reconstruction of body tissue.

The DPC research in areas like these has been effective and productive and represents an appropriate return on the investments made. Several of the groups at DPC are among the international leaders in their field, even compared with larger groups abroad. At the same time, DPC is trying, with some success, to serve the needs of the Danish polymer industry. However, the Panel found it disappointing that only a single industrial Board member was present during the meeting between the DPC Board and the Panel.

III.2 The Structure and Organisation of Research at DPC

Because of the wide range of research activities within DPC, an efficient management structure is particularly critical for its success. The merger between polymer activities at the two, quite different institutions (DTU and Risø) appears to have been difficult. While, as mentioned above, the individual research activities generally function very well, the direct, positive outcomes of the merger are harder to identify. However, it has become easier for outsiders (especially industry) to get in touch with relevant Danish polymer researchers, and the Centre has provided access to strongly improved funding for individual polymer research groups. But it remains a fact that the marriage between polymer science at DTU and Risø has not been fully completed and substantial benefits of the merger probably still remain to be harvested. In particular, it is not clear how DPC decides on long-term research directions and priorities and the co-ordination of these - much still seems to be decided locally. In view of the wide range of activities that the DPC wants to cover and develop further - from polymer synthesis to polymer processing - a clear and well defined management structure and a sharp focus on well defined research areas seem to be lacking.

DPC is in the process of selecting a new Director to replace the present acting Director - the former Director left on a fairly short notice for a job in industry. The documents presented, as well as discussions with the present DPC leadership, made it clear that the new Director will play a critical role in the creation of a strengthened management structure within DPC. It was, for example, made clear by the DPC Board that decisions concerning the direction of research had been and in the future normally would be left to the Director and Deputy Director, in addition to their responsibility for the daily management

of DPC. While this may be satisfactory in the short term, the Panel feels that for the future, this management structure is too flat to ensure the making of the dynamic and effective decisions, which will be required. Especially in view of the present opportunities - based on the many strong research groups in DPC and the willingness of STVF and industry to provide a solid funding base - the Panel considers the present management structure a major weakness of DPC.

It is understandable that the significant structural changes which both Risø and DTU have recently experienced have made the creation of a unified management structure difficult. The Panel was pleased to learn that DTU and Risø are about to sign a new contract that will facilitate improved integration in the future. This is also likely to improve the opportunities for a significantly strengthened management structure needed for a full development of DPC.

The Panel is convinced that the formation of DPC as a national centre for polymer studies and research has made the individual activities more attractive, as partners on an equal basis, for collaboration in European programmes and similar international activities, as well for co-operation with industry. It is necessary that the management structure facilitates and promotes such collaboration and interaction. It may be useful for DPC to compare with the management models that have worked well in a similar context in other European institutions, for example:

- The Dutch Polymer Institute - which is much larger but has similar problems caused by operations taking place at different sites.
- The Max Planck Institute in Mainz, which has succeeded in creating collaboration on a broad range of topics while the aspirations of individual specialists still are respected.
- Chalmers Technical University in Gothenburg, where effective collaboration is common between departments of various disciplines.

III.3 Research Training; Education

Among the outcomes of research institutions like DPC research training is likely to be (one of) the most important - it is usually a win-win situation, since the presence of graduate students is likely to increase the research productivity considerably. Due to the special STVF funding, DPC has been able to allo-

cate funding for a substantial number of Ph.D. students. It is not surprising that training of researchers has been given high priority at DPC – in addition to the training, graduate students and their advisors tend to be a highly productive element in research institutions. DPC expects continuously to have about 20 Ph.D. students and post-doctoral researchers employed. In addition there is a useful supply of Master students from DTU. Most graduate students carry out their research projects at either DTU or Risø, but may also do so in collaboration with other Danish research institutions or commercial enterprises. Presently 2 Ph.D. students are, for example, placed at Aarhus University.

It is not clear to the Panel how difficult it will be to maintain a sufficient supply of quality graduate students in the future. At the moment this supply of students is almost exclusively recruited in Denmark – foreign countries are hardly tapped for talent. However, the present conditions, under which an ample supply of qualified Danish graduate students can be recruited by DPC, may not last. If, for example, the present plans of the Government of Denmark to provide Danish universities, including the S&T fields, with more generous funding, become a reality, Denmark is likely to experience a shortage of talent for graduate S&T programs. However, the high quality research activities and the well equipped infrastructure at DPC must be considered a very positive inducement for recruitment of good students, also from other countries. The activities of the DPC are of interest primarily to chemical engineering, chemistry, and physics students and by increasing the interaction of DPC with relevant departments at universities in Denmark and elsewhere the access to potential graduate students may be increased considerably.

The current Master and Ph.D. research activities at DPC account for a major share of the postgraduate research activities within polymer science in Denmark and there is no doubt that the establishment of DPC has a positive influence on polymer science research training in Denmark, both at the Master and Ph.D. levels. This is important for Danish industry, which, as a result of the improved training, will get access to a larger number of well-trained experts, while opportunities for industrial research co-operation in connection with graduate projects are also improved. For students, the establishment of DPC has made the education profile within polymer science more identifiable, with interdisciplinarity as a key concept in the education at DPC. The Panel noted that the quality of graduate projects was frequently enhanced through integration of complementary skills within various DPC groups. In particular, Danish industry needs graduates who understand processes such as injection molding and extrusion of polymers. Similarly, there is a high demand for

process engineers who understand the polymers and their processing characteristics. The incorporation of Risø scientists, not only in Ph.D. projects, but also in the Master programmes at DTU has clearly resulted in quality improvements, both in the educational activities and in the graduate research being performed.

DPC is presently entering a collaboration with the University of Lund in Sweden, to establish synergies in advanced courses and exchange of students. Even more importantly, DPC is planning to start an international Masters program in the academic year 2003/04, financed through both standard support from the Danish State (generally available for training at the Master level) and individual support from selected industries. The Panel considers this highly appropriate as a sensible extension of the current activities, especially in view of the potential, future recruitment problems. An international Master programme would bring qualified talents from other countries to Denmark and might thus help satisfy the continuous need for talented graduate students; at the same time, it would make the DPC activities more international and acceptable for the EU support. The required international recruitment of students is not likely to become a problem in view of the high standards and excellent infrastructure at DPC, in addition to the planned financial support, financed by industrial grants, for qualified foreign students at DPC.

III.4 The National and International Status of DPC

DPC covers about 80 % of the academic polymer science activities in Denmark. In that sense, it clearly represents a national focus of research in polymer science. Recognition of the DPC as a national centre makes it possible to initiate further integration, both nationally and internationally. The penetration of the DPC into national programs seems to be almost adequate at this time, although attempts should continue to contact the remaining, relevant university research activities in the country and, especially, to increase the number of industrial contacts. On the international scene, the high standards in individual research areas should make it possible for the DPC to participate more actively in the various focus areas identified under the Sixth Framework of EU. Nevertheless, it is clear that Danish polymer research has obtained a visible facade through the establishment of DPC, at both the national and international levels. It may be worth noticing that two DPC researchers recently was given considerable international recognition through the award of the prestigious "Rene Descartes Prize".

III.5 Relations with Industry. Dissemination and Potential Spin-offs

During the Panel's meeting with the DPC Board, the single industrial representative present indicated that one of the obvious, positive results of the creation of the DPC was the "one stop shop" for advice on industrial polymer problems. This new opportunity for industry appeared to be working well. However, it increases the responsibility for DPC, when it is appropriate, to include other relevant researchers in Denmark, also in its relations with industry. There is a strong interest in Danish industry for recruiting the DPC graduates - which provides documentation for the relevance of the current postgraduate training, in which the graduate students take part in exciting interdisciplinary research projects that embrace both polymer chemistry and process engineering. The present feelings in industry have been expressed by Peter Skov, Director of the Danish Plastics Federation:

"The Polymer Centre has a balanced mixture of pure research and applied research and it can play an important part in building bridges between publicly funded research and industry. We also hope that the Centre can attract and train able young job applicants, for which the plastics industry has a great need"

The Panel is not convinced that these aspirations for industrial support from DPC are fully exploited yet. However, there are several positive examples of useful co-operative structures between DPC and Danish industry. For instance, a group of industries with a common interest in a specific research problem may sign a contract with DPC, which will then draw up a strategy for approaching and eventually solving the problem. Another form of co-operation is based on Ph.D. projects in which the Ph.D. student is affiliated with a company and carries out research on a specific problem of interest to the company. DPC also may perform high level services (such as characterisation of polymer molecules) for Danish or foreign polymer industries.

Some concrete examples of ongoing collaborations are:

- Development of artificial muscles for flexible robot fingers, in co-operation with the major Danish industry Danfoss.
- Plastic electronics development, in co-operation with Phillips.
- Development of skin glues for treatment of wounds, in co-operation with the Danish industry Coloplast.

- Development of components for insulin pens and characterisation of plastic surfaces, in co-operation with the leading Danish pharmaceutical company NovoNordisk.
- Development of methods to predict the working life and degradability of plastic components, in co-operation with several companies.

In addition to these industrial examples, DPC has entered into development projects with other Danish institutions in accordance with its role as a national focal point for research and education in the field of polymers. A research activity on fibre composites, presently concentrating on the interaction between fibres and a polymer matrix, is carried out in co-operation with the University of Aalborg. Another example is the development of packaging using bio-plastics which is done in collaboration with the Royal Veterinary and Agricultural University of Denmark.

DPC has developed its interface with Danish industry through a number of initiatives, for example a university-industry association ("MODECS") and, especially, through appointment of young scientists as "project pilots". The latter initiative was highly successful, two project pilots have recently been recruited by industry and have been replaced by new pilots. Active collaboration with Danish industry is evident in several other ways, for example through a number of substantial Centre contracts ("MONEPOL", "HYDECO", "COMF", see Annex 4). However, it was less evident to the Panel that DPC was exploiting the huge potential of co-operation with international polymer companies to a sufficient degree. Such co-operation represents not only a possible source of scientific renewal, but also opportunities for additional income. It is also crucial for involvement in EU programs. Clearly such opportunities must be fully explored well before the end of the STVF support.

The perception within DPC of the Danish polymer industry appears to be based on the fact that the country has no major polymer producer, and that most Danish polymer industries are primarily concerned with polymer processing; this limits their needs and the opportunities of DPC for industrial co-operation. A greater involvement with other EU countries will not only increase the international visibility of the DPC, but would open new opportunities which might promote further development of DPC. Indications of the positive role DPC may play internationally are given, for example, by the high citation rates of DPC research and also by DPC contributions to the "Polymer Newsletter", published for industry. Two small companies are

presently using DPC patents ("Optilink" and "Cartificial"); such dissemination via small companies is very important and the DPC involvement should be kept at the highest possible level.

III.6 Direction and Dynamics of DPC Research; Renewal and Future Development

The current DPC Board and management were hesitant to discuss the future directions of DPC in view of the fact that a new Director is about to be appointed. However, it is clear, especially from the recent annual reports, that DPC have well defined programs for a major proportion of the Centre staff during the next five year period. Much of the ongoing research is highly timely, of good quality; the DPC research programs are generally worthwhile and well suited for further collaboration on an international scale.

The focus areas were less clearly described in the initial internal assessment report received from DPC, but the Panel was able to identify a number of areas of strong competence from the description in the annual reports. However, a careful consideration and possible redefinition of the focus areas may be part of the initial activities of the new Director. The present, new initiatives include the creation of a nano-technology facility (CleaR) at Risø and the establishment of the research professorship in co-operation with the University of Southern Denmark, in order to expand the polymer science activities at DPC to include the interface with biology.

III.7 Impact of DPC on Professional Development; Generation of Synergies

Especially through its M.Sc. and Ph.D. programs, DPC will be able to provide the competent and research trained new, academic staff, which is needed to further develop Danish polymer industry. This may be considered the main outcome, among several, of the Centre investments. In addition (and also to a large extent as an outcome of the graduate programmes) a number of research problems, of industrial or academic interest, may be solved. The positive synergies that would be expected from the merger of polymer activities at DTU and Risø have not yet appeared fully, but the Panel considers this delay, at least partly a result of the recent, significant changes in the management structures of the two institutions. The Board indicated a strong commitment (expressed in the new contract between DTU and Risø) to secure a closer inte-

gration of the two main partners in DPC. One important remedy may be to provide more autonomy for the new management of DPC.

IV. RECOMMENDATIONS

IV.1 Funding

The Panel finds that the performance of DPC warrants continued funding and recommends that the STVF support of DPC is continued beyond the present four year period, in accordance with a proper cascade and fade-out scheme, as for other, similar Danish centres. This will give DPC better possibilities to develop alternative funding sources. DPC has just about the critical mass to fulfil the given tasks and to satisfy the demands from its different partners. A significant lowering of the budget would endanger the merger processes, which so far has not come far enough, as well as the positive developments which have been achieved during the last three years.

At the same time, it is important that the management of DPC keeps in mind that the present funding situation is likely to change and starts work on the development of a business plan that can ensure sustainability in the future. The establishment of this business plan must include consultations, not only with the present funding bodies, but also with a wider range of industries, and it must be supported actively by the DPC Board. It is important that DPC starts implementing new funding strategies without delay (i.e. through the establishment of co-operation with larger, international industries, EU contracts, etc.) in order to gain more extensive experience in income creation as soon as possible. However, DPC must also continue to explore opportunities for provision of analytical and technical services to Danish polymer industry, both as an important part of the main duties of DPC, for renewal of research and education, and as a mechanism of enhancing its funding base.

IV.2 Research

Strategies must be developed to avoid potential, excessive duplication of facilities and activities at the Risø and DTU sites. In this connection there are issues of access that must be considered, but it would not be appropriate to develop,

for example, synthesis, characterisation and polymer processing, further at both sites. A strategy that prevents duplication of infrastructure and skills will allow an enhancement of the infrastructure to support the identified focus areas more efficiently. For instance, DPC may consider concentrating future developments of polymer chemistry at Risø and concentrating development of polymer processing and engineering activities at DTU.

DPC should develop a clearer policy in support of polymer industry in Denmark, especially the processing industry. The creation of an industrial liaison group would aid the clarification of priorities in relation to the demands and needs of the polymer industry. As described above, DPC has already a considerable number of co-operative projects with industry; these must be evaluated and other project groups at DPC must learn from these examples. Once an industrial research project is concluded, the general know-how it has created must be disseminated as widely as possible to industry, using all channels available, including such bodies as the Danish Technological Institutes.

The focus areas indicated in the internal assessment document should be re-defined and adapted to the current activities and needs at DPC. For example, the work on oxygen diffusion, which takes place in Aarhus, has a clear relevance for the development of smart packaging that might give rise to a special focus area. The work on new chemistries and photoelectric polymeric devices have a long term potential for important applications, for example in connection with sustainable energy. A similar potential exist for the work on biomimicking surfaces. In addition, such activities have a potential for promoting public recognition and acceptance of DPC.

IV.3 Organisation and Management

The Panel finds that DPC at the moment does not possess a management structure that can efficiently promote further growth. It is proposed to formally establish a scientific steering group to continuously adjust the future directions of the research activities, to assess the extent to which the current activities are achieving their stated objectives, and to provide a platform for the development of a vision for the future of DPC. Clearly, specific individuals are responsible for particular focus areas of DPC. However, this does not ensure the level of co-operation and integration that is needed. For example, at the Max Planck Institute in Mainz, specialists work in particular areas but also in large collaborative teams in which several specialists take part. A similar organisational framework might be useful for the further development of DPC.

It is also recommended that a broad, representative industrial liaison committee is established, to enhance and strengthen the interface with Danish polymer industry. A review of the "project pilot" scheme, which has been widely praised, should be undertaken in order to determine its value for the development of DPC-industry co-operation. It is specifically recommended that DPC tries to play a more active role in the EU 6th framework program – DPC is able to offer specific skills which can be easily integrated into international programs.

Finally, the Panel strongly recommends that the DPC Board takes a more active role in the development of a united DPC, that it helps provide incentives for a more efficient integration of the two partners, supports the necessary fund-raising activities actively, and that it tries to broaden its role by providing advice the DPC management on both scientific, financial, and managerial (structural) questions.

IV.4 Recruitment, Educational Activities, and Communication with Users and the General Public

If the International Masters Programme in Polymer Science is established as planned, it is likely to broaden the access to qualified and talented students. For this reason alone, its implementation should be give high priority. The proposed collaboration with the University of Lund to establish synergy in advanced courses and exchange of students is strongly recommended. The Panel further recommends expansion of such activities to include also other Danish universities, in addition to those already included.

The Panel also supports the expansion of DPC activities in postgraduate and in-service education via short one- or two-day courses, targeting both industry and possibly also DPC students, as well as students from other institutions. DPC might even consider establishing a program of continuous professional development courses to support the Danish polymer industry. If this is done as an extension of the regular M.Sc. and Ph.D. educational activities, such support of industrial needs would not only be appropriate, but also economical. Also the introduction of a programme of regular seminars, targeting students, industry, and occasionally also the general public (e.g. high school students), may be useful.

The visibility of DPC to both users and the general public must be further improved. The DPC web-site does not fully reflect the importance of the Centre to Danish polymer science and, especially, industry. DPC must, under a fu-

ture, united leadership, more actively accept its responsibility for the intellectual leadership of polymer science in Denmark that comes with the present DPC expertise and resources. The opportunities for demonstrating such leadership further are many and include the organisation of yearly national meetings for all involved in polymer science.

IV.5 Collaboration with Industry

The fact that the Danish polymer industry places high priority on both pure and applied research opens several opportunities for DPC. Industry is keenly interested in the creation of new polymer knowledge, the knowledge dissemination, and the training of competent young polymer scientists at DPC. Research is essential to the survival of the Danish polymer industry, which has to retain its competitive edge in the face of considerable international competition. The Danish Plastics Federation has produced a catalogue of topics that defines the industry's most important research needs, in the hope that Danish universities and research institutions will devote their attention to these subjects. It is very important that DPC reacts to this catalogue, accommodates industry to the extent possible, and at least enters into a dialogue with industry when this is not possible. It is important that the present and potential future importance of the DPC remains widely recognised by industry.

V. MAIN CONCLUSIONS

The strategic importance of polymeric materials, in both economic and technological developments, necessitates that Denmark should have a resource centre in polymer research, and the Panel supports the development of the DPC as a centre for polymer science in Denmark. The Panel believes that the progress made during the last few years warrants a continuation of the funding to the Centre to its next state of development, and recommends that the support is continued beyond the present four year period.

The Panel was generally impressed by the facilities being developed and with the wide range of high quality research and training taking place in the DPC. However, the Panel had concerns about the slow progress in the integration between the DPC partners, and the lack of a united, effective management structure, without which DPC will never become fully efficient and sustain-

able. DPC is encouraged to create more, effective links with Danish and foreign industries, to enter more extensively into EU collaboration, and to start seeking and developing financial sources for a future without the present STVF support. not only to secure further scientific progress, but also to create a realistic possibility for a transition to alternative funding sources. The planned development of an International Master programme is strongly recommended. With its present scientific competence and improved facilities, DPC has an obvious opportunity to become a true focal point for polymer science in Denmark.

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ANNEX 1. TERMS OF REFERENCES

for evaluation of the Danish Polymer Centre

1. Background and purpose

The core of the Danish Polymer Centre (DPC) is provided by the Department of Chemical and the Department of Manufacturing Engineering at the Technical University of Denmark together with the Polymer Department at Risø National Laboratory and with facilities at both institutions.

The terms of contract of the DPC is regulated by "Aftale mellem Danmarks Tekniske Universitet og Forskningscenter Risø om etablering af Dansk Polymer Center".

As a consequence of the above mentioned "Aftale", a board was formed with members from both institutions as well as external members. The board supervises the contract with STVF and approves the annual work plans.

The central grant to DPC from STVF (40 mio. DKK) was in two parts. 10 mio. DKK was allocated directly to DTU to renovate two floors of Building 423 to provide common facilities for DPC at DTU. The new facilities were ready in Jan 2001.

The remainder of the grant was to be spent on research and educational activities.

STVF has decided that a 3/4 term evaluation of the centre is to be carried out in the Spring/Summer of 2002.

It is the task of the international panel to evaluate the outcome of the research programme until now and the potential for its future development.

2. Form and extent

The basic principle of the evaluation will be peer reviews of the main research activities at DPC. Also DPCs engagement in strengthening the graduate and Ph.D. education and other educational activities such as continuing education

are to be evaluated.

The Main activities at DPC are:

1. To develop/expand the established Danish position of strength within polymer science by securing an effective and visible effort of high international standard.
2. To intensify the education of highly qualified candidates and Ph.D.s through the establishment of an attractive environment for students.
3. To develop into a national centre for polymer research and education.
4. To secure an effective and mutually binding co-operation between the industry and the research sector.
5. To initiate new activities, which will form the basis for further industrial growth in the field.

Also the ability to attract externally financed research projects e.g. from European Unions research- programmes shall be evaluated.

The evaluation of DPC will include opinions on the relevance of the research, dissemination of R&D results, and contributions to training of researchers. In addition the evaluation must include assessment of DPCs planning of future activities.

3. The evaluation panel.

Within the field of DPCs activities 4-5 experts, appointed by STVF partly based on suggestions from the DPC, will carry out the evaluation.

A scientist of high standing, who must be knowledgeable about the Danish research environment and administration, will head the evaluation panel.

DPC will have an opportunity to comment on the chosen panel members.

The panel will be formed in May 2002.

4. Division and allocation of responsibility.

STVF will be responsible for the evaluation, which will be based on relevant documentation from DPC. It will also include a visit to DPC for the participants in the evaluation panel and interviews with some of the collaboration partners.

DPC will arrange the visit and interviews, and the chairman for the evaluation panel should well in advance adopt the plan for the visits.

5. Main tasks

The evaluation shall be based on DPCs plans, annual reports and a self-evaluation report, and shall take account of the main activities of DPC described above.

In addition the panel can draw on other relevant material including publications combined with visits and interviews.

The evaluation shall include considerations and conclusions about each of the five main activities of DPC, i.e.

1. The extent and scientific quality of DPCs research activities, its structure and organisation and its international position and impact. This point should include an evaluation of any scientific or structural weaknesses.
2. The status of the environment for MSc and PhD education.
3. The status of DPC as a national polymer research centre including national and international collaboration in relation to EU and national programmes.
4. The co-operation between DPC and the industry as well as the dissemination of results to the industry.
5. The direction and dynamics of DPCs research activities, and its ability to renew the research directions. The potential for future development.

In addition to this:

- What is the overall evaluation of the activities at DPC compared to other similar research groups in the world?
- How has the Centre organisation and its leadership impacted on professional development, creativity, efficiency, and generation of synergy?

6. Organisation

DPC will supply the necessary background materials to facilitate the evaluation.

7. Procedure

STVF will initiate the evaluation and will appoint the members of the evaluation panel.

DPC will arrange visits to the centre and to its co-operation partners and supply practical assistance to support the evaluation upon request.

8. Time schedule

The chairman and the members of the evaluation panel will be nominated and notified in June 2002.

The evaluation will be carried out in August/September 2002.

9. Funds and resources

DPC will pay the cost of their own participation in the evaluation.

ANNEX 2. THE EVALUATION PANEL

Professor *Erik W. Thulstrup* (chairman)
Department of Life Sciences and Chemistry
Roskilde University
Denmark

Professor *FPT. Baaijens*
Eindhoven University of Technology
Biomedical Engineering Material Technology
The Netherlands

Professor *Roland Keunings*
CESAME
Division of Applied Mechanics
Université Catholique de Louvain
Belgium

Professor *Richard A Pethrick*
Department of Pure & Applied Chemistry
University of Strathclyde
Scotland UK

Professor *Markus Antoietti*
Max Planck Institute of Colloids and Interfaces
Colloid Department
Germany

ANNEX 3. PROGRAMME FOR THE PANEL VISITS

Programme for the Evaluation of the Danish Polymer Centre
12. and 13. September 2002.

The evaluation will take place at the Danish Polymer Centre,
The Technical University of Denmark, Building 423,
Produktionstorvet, 2800 Lyngby, Denmark Tel: 45256800.

11/9 Evaluators Arrive at Hellerup Park Hotel, Strandvejen 203,
Hellerup
19.00 Dinner with the chairman of the Danish Technical Research
Council at Restaurant Saison, Hellerup Parkhotel

12/9
From 7.00: Breakfast at the Hellerup Park Hotel
8.15 Depart from Hellerup Park Hotel to DTU, Build. 423.

At DPC –DTU:

8.30-9:00 Panels Internal discussions.
9:00-10:00 Meeting with The Centre directors. Visit to DTU labs
10:00-10:20 New Functional Polymers / *Søren Hvilsted*
10:20-10:40 Elongational rheology / *Anders Bach*
10:40-11:00 Polymer fluid dynamics / *Henrik Koblitz Rasmussen*
11:00-12:00 Time for writing of report
12:00-13:15 Transport to Risø and Lunch

At DPC-Risø:

13:20-13:40 Oxygen in polymers / *Peter Ogilby*
13:40-14:00 Bio-composites / *David Plackett*
14:00-14:20 Modelling of Rubber viscoelasticity / *Anne Larsen*
14:20-14:30 Break/coffee
14:30-14:50 Polymer solar Cells / *Frederik Christian Krebs*
14:50-15:10 Biomimicking polymer surfaces / *Niels Bent Larsen*
15:10-16:30 Visit to Risø Labs and return to DTU
16:30-17:30 Time for writing of report
17:30-18:30 Meeting with The Board of the Centre incl. Industrial
Members
18.30- Dinner with Board and Centre directors

13/9

8.00 – 8.30 Breakfast
8.30 –16.00 Panel meeting and writing report at Hellerup Park Hotel
12.00 Lunch
Ca. 16.00 Depart from the hotel

ANNEX 4. THE DPC SELF-ASSESSMENT

Extended version (September 2002) of the Internal assessment of the Danish Polymer Centre, received August 2002.

Documents relating to this report are labelled Source Documents (SD1-SD8) and appear in the annex. Links to web sites have been given directly in the text.

List of contents:

- History
- Collaborative partners, including national partners in the Centre
- Legal status
- Centre organisation
- Board and management
- Staff
- Funding overview
 - o STVF and institutional funding 1999-2003
 - o Centre related donations

History

The Danish Polymer Centre (DPC) is based on collaboration between research groups at the Technical University of Denmark (DTU) www.dtu.dk and Risø National Laboratory (Risø) www.risoe.dk under the so-called MUP-2 programme (1994-98). The Centre started its activities in October 1999 based on a collaboration agreement signed in March 1999 and with significant support from the Danish Research Agency (STVF) and Danish industry.

Collaborative partners

The Department of Chemical Engineering and the Department of Manufacturing Engineering and Management at DTU, together with the Polymer Department at Risø National Laboratory, provide the core of the Danish Polymer Centre. The purpose of the Centre formation was to create an efficient research and training environment in close cooperation with other public research institutions and with Danish industry.

As required in the contract with STVF, DPC has initiated the formation of a national network. Aarhus University and Ålborg University have entered into binding agreements with the Centre and researchers from four other depart-

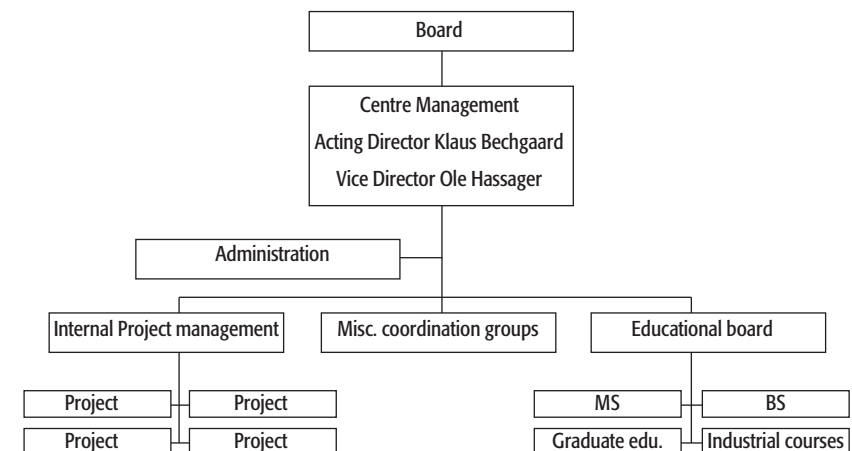
ments at Risø are involved in DPC activities. An agreement with University of Southern Denmark will be signed in the fall of 2002.

Legal status

The terms of contract of the DPC were regulated by the document entitled "Aftale mellem Danmarks Tekniske Universitet og Forskningscenter Risø om etablering af Dansk Polymer Center". Under this contract a Board was formed with members from both institutions as well as external members. The Board supervises the contract with STVF and approves the annual work plans.

From 2002 DTU operates under new statutes and therefore a revision of the Centre's legal foundation is needed. The Managements of DTU and Risø and the Board of the Centre have initiated this work and it is expected that a new agreement will be signed during the summer of 2002. The new statutes will be forwarded to the evaluation committee as soon as they become available.

The Board and management



The Board consists of: Prorector *Knut Conradsen*, DTU (chairman) – Director *Jørgen Kjems*, Risø (vice chairman) – Department Head *Leo Alting*, DTU – Department Head *Kim Dam-Johansen*, DTU – Research Director *Peter Samuelson*, Coloplast A/S – Development Manager *Bjørn Marcher*, Monarflex A/S – Production Manager *Flemming M. Pedersen*, Bang & Olufsen A/S – Senior Scientist *Keld West*, Risø – Assistant Professor *Martin E. Vigild*, DTU.

Role of the Centre Board

The collaborative agreement between the DTU and Risø defines the role of the Board. The Board approves the annual plans and long-term strategies of the Centre. This includes the Centre directors plan for utilisation of the Centre-grant from STVF, which amounts to about 14 % of the total annual turnover.

Both parent institutions now operate under the Danish management model called "management by objectives and framework" (mål- og rammestyning). This means that the Department Head of the Polymer Department at Risø (at present also the acting Centre Director) negotiates Risø allocated objectives and framework (read: Base funding and expected external funding) with the Risø management. The Vice Director (Professor at DTU) negotiates similarly with the two Department heads at DTU regarding teaching obligations, external funding and number of permanent positions and running costs allocated to Polymer Centre activities.

Centre Management:

The Director of the Centre from the outset was Ib Johannsen. In December 2001 he decided to accept a position in a Danish company. Ib Johannsen's contributions to the establishment and running of the Centre and to the construction of the new facilities are strongly acknowledged among his colleagues. A new Centre Director will be appointed following the installation of new statutes. Klaus Bechgaard has been appointed acting Centre Director in the interim period.

The Centre Director and Vice Director with 4 researchers form a steering committee which meets twice a month to discuss and approve smaller investments, new projects and hiring of temporary personnel.

Facilities

The design of the new laboratories at DTU was started in 1999. This created the basis for obtaining official approval from the Ministry of Research to start up the building project for building 423 at DTU. Excellent laboratories (~500 sqm.) with adjoining office space were established on the two top floors of the building. The new facilities were finished on schedule and were occupied in January 2001.

The process laboratories in building 427 at DTU have also been reorganised and expanded to give room for new activities. This work started late 1999 and



Entrance to the new laboratories in building 423, DTU established in 2001.

the first process hall was finished in early 2000. A clean room facility for microinjection moulding was completed in the summer of 2000. At Risø the process of concentrating the activities in building 111 and 124 started in 2000 and will be finished in 2002. Some activities were moved to DTU. A new large clean room facility (150 sqm) and adjoining laboratories designated for polymers and biological applications (soft nanotechnology) is planned at Risø. If the final 30 mio Dkr project is approved by Risø's Board in September 2002 the laboratories will be operational in April 2003.

In the laboratories at DTU and Risø a broad range of polymer synthesis and characterisation techniques are available. <http://www.polymers.dk/instruments/instruments.htm>

Staff

From the start of the Centre an important objective was to integrate two research cultures from a university and a national laboratory. In support of this objective, funding (0.4 mio Dkr) was obtained for a project called "Common values in DPC" and several successful one- and two-day seminars were held. As a result there was a better common understanding of the Centre and its role as well as improved integration of the two research cultures.



Polymer centre staff

The Polymer Centre in 2002 has some 23 permanent academic staff, 12 technical staff, 4 administrative staff, 14 research associates, 15 PhD students and about 15 Master's and other project students. The academic staff group has a rather attractive age profile for a Danish research team as 10 members are below 40 years of age. During 1999-2002 two staff members were promoted to full professorships and one staff member obtained a research professorship.

Funding-overview (details on pages 12-15).

The primary funding for the Centre comes from DTU and from Risø National Laboratory. The Danish Research Agency (STVF) allocated 40 mio Dkr covering the period 1999-2003, of which 10 mio Dkr was designated for the building of new facilities and 30 mio Dkr (7.5 mio Dkr per year) was budgeted to cover investments, running costs, PhD stipends and post docs.

DTU granted the Centre a reduction of overhead costs on the STVF grant (from 20 to 3 %) in return for the 10 mio Dkr designated for new laboratories and Risø has invested a further 2 mio Dkr in buildings and 4 mio Dkr in major equipment.

DPC also receives other major national research grants as well as grants from the EU and funds from a range of industrial enterprises and other private

sources. We are very grateful to Aage and Johanne Louis-Hansen's Fund which has donated a five-year Research Professorship to the Centre (1 mio Dkr/year).

The total income from these other grants will be 13.6 mio Dkr. The commercial income is expected to be 5.0 mio Dkr in 2002.

The net annual turnover in 2002 is expected to be:	42.0 mio Dkr
+ overheads	<u>13.7 mio Dkr</u>
Total	55.7 mio Dkr

Source documents: Statutes (SD1), STVF grant application (SD2). Activity report The Danish Polymer Centre 1999/2000 (SD3). The Danish Polymer Centre Annual Report 2001 (SD4)

PREVIOUS EVALUATIONS

The Danish Polymer Centre was partly evaluated in connection with a general evaluation of Risø National Laboratory in January 2001. The conclusions are found at: <http://www.videnskabsministeriet.dk/fsk/publ/2001/risoe/risoe.pdf> pages 56-57.

The previous collaboration under the MUP 2 programme was also evaluated in 1998. <http://www.forsk.dk/stvf/publ/eval/mup2/chap3-5.htm>

NATIONAL AND INTERNATIONAL ROLE OF THE CENTRE.

The national and international role of the Centre is documented in the many collaborative research contracts and internationally co-authored publications of the centre.

Nationally, the Centre collaborates intensively with researchers at nearly all the Danish universities and with a large number of companies. Formal Agreements on co-sponsorship have been signed between the Centre and the universities of Aarhus and Ålborg.

Internationally the Centre is strongly involved in EU-funded research contracts and work with many of the major research groups in Europe and the United States as well as with some Japanese colleagues.

Researchers from the Centre regularly utilise major experimental facilities in Europe. A formal collaborative agreement with the Paul Scherrer Institute in Switzerland has transferred Risø's Small Angle Neutron Scattering Instrument

(SANS) to this institution after the closure of Risø's neutron scattering facilities. Centre members are also strongly involved in the European initiative to build the next generation Neutron Scattering Facilities (the European Spallation Source (ESS) initiative).

Source Documents Activity report The Danish Polymer Centre 1999/2000 (SD3, The Danish Polymer Centre Annual Report 2001 (SD4). List of publications (SD5), List of Research Contracts (SD6).

RESEARCH AREAS

- Focus areas 1-4
- Polymer composites

In line with the original research proposed for the Polymer Centre the main STVF- funded activities have been conducted within the four focus areas described below (with a short rationale):

Focus area 1: New Polymer Materials.

The synthesis of materials with new and well-defined properties is considered important for future breakthroughs and applications. Theoretical modelling of the interplay between molecular structure and functional properties will give valuable input for the design of novel materials. Specially synthesised model polymers are important for the investigation of predicted or anticipated relations between structure and properties. The polymer Centre has synthetic groups working on a variety of methods for polymer synthesis. From strongholds in atom transfer radical polymerisation, anion induced polymerisation and metathesis reactions, materials are made for fundamental studies as well as for exploitation of a particular functional property

A highlight in this work has been the development of photonic polymers which form the basis for the development of materials for optical holography and other optical storage. These materials developed in collaboration with the Department of Optics and Fluid Dynamics at Risø besides from giving fundamental insight has formed the basis for the start-up company Optilink A/B. Contact; S. Hvilsted.

Publications # 2, 26, 27, 48, 56, 57, 60, 61, 84, 92, 93, 99, 104, 127, 140, 173, 174, 177, 196, 200, 201, 205, 222, 225, 230

Other contacts in synthesis of new Polymer Materials J. Kops.

Publications, # : 12, 32, 33, 36, 48, 83, 86, 150, 176, 206,

Focus area 2: Polymer Blends and Networks.

Multi-component systems are essential in polymer applications and include polymer blends and colloids. Complex morphologies can be obtained and controlled by clever molecular design and modification of interfaces, which in turn can open up new applications for polymers in nanotechnology. Cross-linking of polymer systems is another way of changing the material properties and creating new materials via the formation of networks. Studies of structure and dynamics are necessary to better understand the properties of such materials.

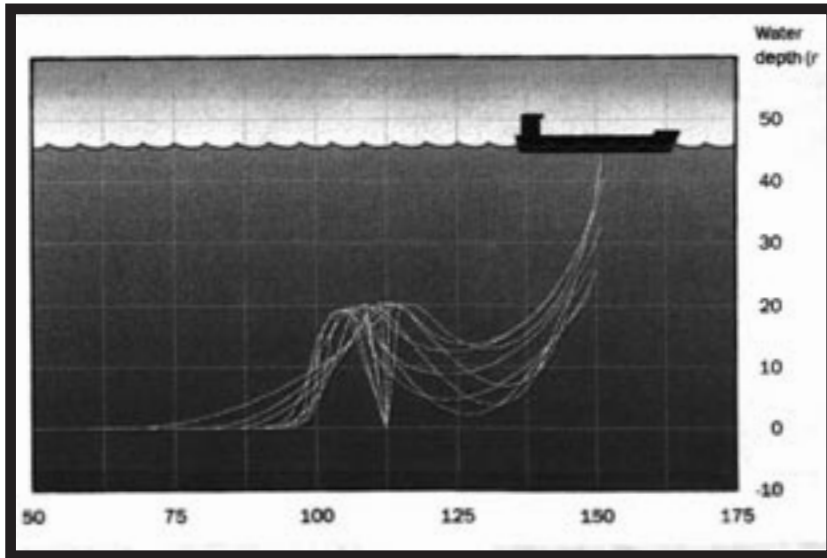
The area has in collaboration with several other groups investigated the structure and dynamics of blends of block copolymers AB with homopolymers A and B. At a suitable choice of molar mass and composition this polymeric system exhibits the critical isotropic Lifshitz point. This polymeric system is so far the only realization of this point and these studies are of interest beyond the polymer community (publications #20, 25, 47, 65, 124, 141, 142, 145, 185, 224). Intricate ordered structures can be observed in ABC triblock copolymers. It has been shown that an obvious shortcut to such structures – blending of two diblock copolymers – is not feasible (publications #128, 167, 168). Substantial work towards an extension of the understanding of block copolymer dynamic and thermodynamic has also taken place (publications #17, 19, 22, 28, 53, 54, 62, 63, 100, 101, 129, 130, 131, 153, 169, 170, 171, 175, 182, 204, 209, 211, 212, 214, 219). A highlight of work on polymer gels and networks has been the results obtained by using a combination of rheology and small angle neutron scattering techniques on thermoplastic SEBS gels and on a bicomponent network. Furthermore solid-state NMR techniques have been used for network characterization (publications # 40, 110, 149, 178).

Contacts K. Mortensen K. Almdal

Focus area 3: Structural Development of Polymer Melts at Processing Conditions.

Processing of polymers spans a range of mechanical deformations (e.g. shear strain and extensional flow). This has a dramatic impact on structure and, in order to understand and utilise the effects of strains and flows, the influence of processing on material properties can be studied by rheology, molecular modelling and in-situ scattering techniques as well as transmission electron microscopy for the direct imaging of morphology.

A highlight of this work is the development of a filament stretching rheometer for the measurement of transient elongational viscosity of polymer melts.



Flexible pipes are used in the off-shore industry for the transportation of oil and gas from wells to ships

The instrument is capable of reaching deformations that match or even exceeds the Meissner rheometer located at the ETH in Zürich which is considered the best instrument to date. The instrument opens an entire new avenue of research possibilities. To name but one example, current work indicates that the instrument is capable of measuring the elongational viscosity of monodisperse polystyrene. These measurements, which have to date not been possible, have crucial importance in the understanding of constitutive equations for linear polymer melts based on the reptation concept of Nobel laureate P.G. DeGennes. Contacts: O. Hassager, H.K.Rasmussen.

References: Annual report 2001, pp24-25, # 58,59,202.

6, 23, 35, 42, 43, 44, 45, 49, 95, 126, 137, 158, 161, 195, 217, 218,

Focus area 4: Advanced Processing Technologies.

Modelling of sophisticated processing methods can be of valuable importance, as it may short-cut elaborate trial and error based development. Production of components with micrometre and nanometre structures is an important research area. Advanced processing such as two-component injection moulding and multi-layer extrusion can be used to create structured materials. Modelling is performed to understand and examine different process geometries and

conditions. For this purpose, the centre has developed the first finite element method for the simulation of transient free surface polymer flow in 3 dimensions. In combination with rheological characterization, the method can be used to analyze a range of polymer processing operations including blow moulding, thermoforming and fibre spinning.

References: Annual report 28-29, #23,137.

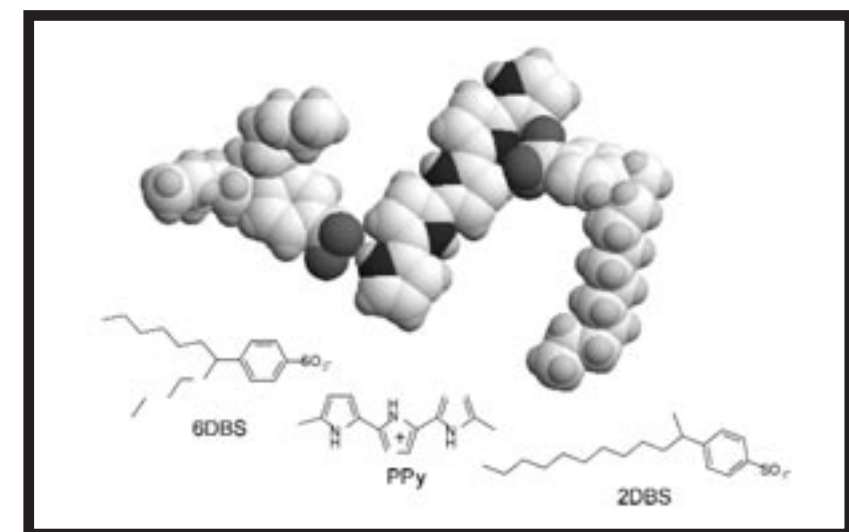
Among the technologies developed was microfabrication of actuators. A further highlight has been the development of a technology for depositing coorugated electrodes for dielectric elastomer actuators which strongly improved the performance. This technology was patented by the Danish company Danfoss A/S. Contact: P.Sommer-Larsen. K West. Reference Annual report 2001 p 16-19, Publications # 30, 31, 68, 69, 70, 71, 103, 109, 134, 190 210

A recent highlight has been the development of injection moulding techniques for biomimetic Polymer nanostructures where biological (nanoscale) features structures can be replicated in polymer materials. The same technology can produce integrated optical patterns intended for sensor user in polymer surfaces.

Contact N.B.Larsen References Annual report 2001 pages 26-27, publication # 221.

Other publications # 13, 58, 59, , 74, 78, , 138, 156, , 202,

Poly pyrrole (PPy) is one of the conjugated polymers showing an appreciable conductivity in the oxidised ("doped") state



Polymer composites

The centre also has strong activities relating to polymer composites. These include expanding research in nanocomposites and biocomposites.

An important result of the centres composite work has been the participation in a new start-up company based on a Polymer Centre developed concept of a simple polyethylene composite designed to function as artificial cartilage in human joints (in arthritis patients) based on an original idea of professor Jes Bruun Lauritzen (Bispebjerg Hospital(see patent number 3).)

Also work on composites based on natural fibres and/or biodegradable polymers is progressing.

Researchers from the Materials Science Department at Risø participates in both projects.

Contacts:: Klaus Bechgaard and David Plackett

References Publ #160 ,228 Patent #3)

General description of results

Referring to the two activity reports (SD3, SD4), the particular research conducted within the areas has taken many directions which are described in more detail in the annual reports as well as in the more than 230 publications from 1999-2002 in international refereed periodicals as documented in the publication list.

Research contracts

Name	Project leader	Length of contract	Type of Contract	Grants 2002 kkr.	Market 2002 kkr	Total kkr
Research professorship	Søren Hvilsted	00-05	Private donation	1000	0	5000
Functional block copolymers	Søren Hvilsted	01-05	STVF funding	772	0	2000
Talent project	Frederik Krebs	01-02	STVF funding	480	0	960
EFP-PSO solar cells	Keld West	02-03	Danish energy Agency	1150	0	1150
CAPS (complex polymer blends)	Kristoffer Almdal	99-02	EU-TMR Network	250	0	1892
BIOPACK	Kell Mortensen	01-04	EU	750	0	1738
Structural control on nano/microscale	Martin M. Nielsen	01-04	STVF funding	500	0	2999
FREQUENT	Martin M. Nielsen	02	EU Descartes price	446	0	446
Conducting Polymers	J. Lyngaae-Jørgensen	01-04	NKT research academy-DTU	443	0	1300
Structure of multiphase polymer systems	J. Lyngaae-Jørgensen	98-02	STVF funding	570	0	2850
Talent project	Niels Bent Larsen	00-03	STVF funding	1050	0	2893
Dynamics of Polymer liquids	Ole Hassager	98-02	EU-TMR network	240	0	1500
Smaller programme contracts	nn	not relevant	programme	240	0	n.r.

Source documents: Activity report The Danish Polymer Centre 1999/2000(SD3), The Danish Polymer Centre Annual Report 2001 (SD4). List of publications (SD5).

DISSEMINATION OF RESULTS

- Refereed Publications
- Other publications

Refereed Publications (List including citations taken in July 2002)

From January 1999 until July 2002 members of the Centre published 230 papers in international refereed publications. A simple citation analysis using raw data from Web of Science was performed. The citation frequencies are given in the Table.

Table: Refereed publications and their citations sampled in July 2002.

Publication Year	Ref. Publications	Citations	Av. Citation
1999	78	624	8.00
2000	73	204	2.79
2001	64	97	1.50
Reg. July 2002	15	1	0.07
Total	230	926	-

Source Document: List of refereed publications with citations (SD5)

Other publications

For listings of

- 11 Patents
- 10 Book chapters
- Over 100 Conference reports and lectures
- 10 Publications for a broader readership
- 5 News letters, Brochures etc.

Please refer to: Activity report The Danish Polymer Centre 1999/2000 (SD3) p. 29-35, The Danish Polymer Centre Annual Report 2001 (SD4) p. 37-40 and SD7.

AWARDS

Martin M. Nielsen and Klaus Bechgaard received the 2000 "Rene Descartes Prize" of 400 kEuro together with Dutch, British and German colleagues for pioneering work in correlating structure and performance of polymer field effect transistors (SD5 publ. no 63).

External funding of research:

In addition to the base funding from the institutions and STVF, the Centre in 2002 holds research grants with an expected turnover of 13.6 mio Dkr and four major and several minor commercial contracts generating a turnover of 4.8 mio Dkr.

Source documents: List of Research Contracts (SD6)

- General Education
- International Master's Program.
- PhD School.
- Candidate production.

General Education

Prior to the formation of the Centre in 1999, polymer education at DTU was distributed over four departments with little, if any, coordination between the polymer courses. After the formation of the Centre, a committee was established with the purpose of formulating a coherent structure for the polymer curriculum at DTU.

In parallel to this initiative two organisational changes occurred at the university. First, DTU introduced a change in the educational system away from a structure with a large number of courses, typically either theoretical or laboratory exercises, to a structure with fewer but larger course units that integrate theory with laboratory work. Second, the number of departments was reduced from 34 to 15 by January 2001.

Based on the proposal from the Centre curriculum committee, new polymer courses were implemented beginning in the fall of 2001 as follows:

Course number	Course name	Participants fall 2001	Participants spring 2002
28212	Polymer chemistry	-	34
28213	Polymer technology	27	-
28315	Colloid and surface science	12	-
28414	Rheology	8	-
42230	Polymer processes	(not given)	-
42232	Design of plastic products	-	16
42234	Experimental plastics technology	-	5
42935	Injection moulding	19	-
42947	Thermoforming	3	-
42949	Simulation of injection moulding	-	6

Table: Participants in polymer courses at DTU. Course numbers starting with "28" refer to the Department of Chemical Engineering, while courses starting with "42" refer to the Department of Manufacturing Engineering and Manage-

ment. Courses with "9" as the third digit are designed for the Bachelor of Science in Mechanical Engineering. Courses are given either spring or fall as indicated in the table. Course 42230 was not given in the fall of 2001 due to an insufficient number of registered participants.

International Master's Programme.

The centre has proposed an International Master of Polymer Engineering and Science education. The program is intended for students who have a relevant B.Sc. degree from their home university. It is a two-year program expected to start in September 2003 in cooperation with Danish polymer companies. In particular, the students may be associated with a Danish company at least for the duration of the thesis project.

The program will be administrated by DTU. Stipends will be available for a limited number of students, partly sponsored by the Government and partly by the companies involved. More on the existing International Masters Programmes may be found at <http://www.msc.dtu.dk/>.

Classroom instruction of B.Sc. students



PhD School.

The Centre currently has 15 PhD students. In addition, the Centre has submitted a proposal for support of a Graduate School in Polymer Science to the Danish Research Agency. The school will be an extension of the existing PhD education in the Centre. Specifically, the application involved partial support for a total of 18 PhD stipends in the years 2003 - 2007.

Candidate production.

The total candidate production is given in tabular form:

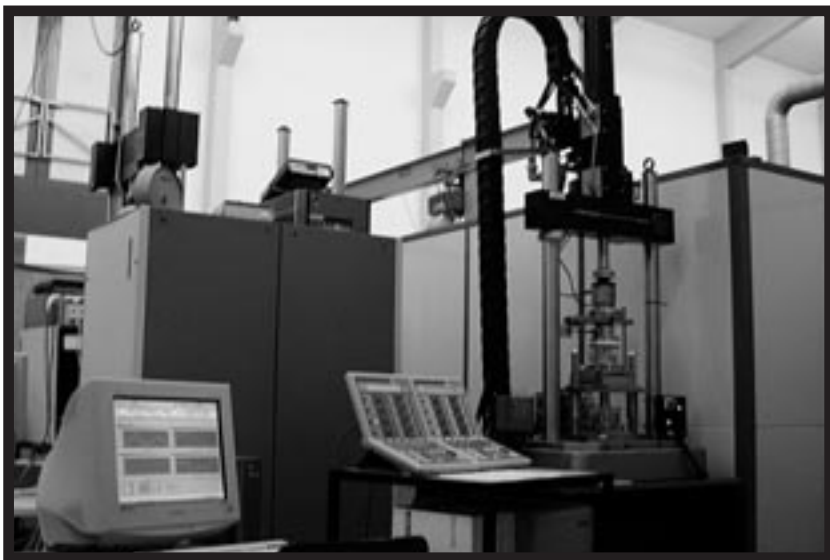
	1999	2000	2001	July 2002
B.Sc.	3	8	6	2
M.Sc.	7	4	8	7
PhD	1	2	7	2

COLLABORATION WITH INDUSTRY

- Centre Contracts
- R&D contracts and Consultancies
- Patents
- Start up companies utilizing Polymer Centre Patents
- Industrial Forum
- Project pilots
- Courses

Public Contracts with strong industrial involvement

Name	Project leader	Length of contract	Type of Contract	Grants 2002 kkr.	Market 2002 kkr	Total kkr
MONEPOL	Kristoffer Almdal	01-05	"Erhvervsfremmestyrelsen"	2800	0	5195
Bromfri	Kell Mortensen	01-03	Danish Env.Agency	1000	0	2531
INSULIN	Kell Mortensen	01-02	EU-CRAFT	1000	0	1863
Hydeko	Niels Bent Larsen	98-02	"Erhvervsfremmestyrelsen"	200	0	2769
COMF	Niels Bent Larsen	99-02	"Erhvervsfremmestyrelsen"	750	0	4300



Experimental set-up for simulating materials wear due to continued exposure to friction, pressure etc.

Centre Contracts

The Danish Polymer Centre is currently involved in three Centre Contracts. The term covers a juridical binding collaboration between companies, research institutions and technological service institutes like the Danish Technological Institute. The aim of the Centre Contracts is to create a common effort in strategic research and development projects with a commercial appeal. The Centre Contracts make it possible for industry to get access to the newest results in the fields of research and technological development. The Centre Contracts are also intended to support tangible renewals within Danish companies by uniting the best qualities and abilities of the industry, research institutions and technological service institutes.

In 2002 the Danish Polymer Centre is involved in three Centre Contracts:

- MONEPOL: A project concerned with understanding the processes, which chemically and environmentally degrade polymers, in order to exploit this in future applications.
- HYDECO: A project that deals with hygienic design and cleaning of process equipment in the comestible industry.
- COMF: A project concerned with surface metrology and functionality.

Companies involved in these Centre Contracts include Coloplast, Danfoss, Grundfos, Lego, Løgstør Rør, NKT Research, Novo Nordisk and Radiometer. In 2001 the Centre finished a major public contract obtained with Danfoss dealing with development of artificial muscles (ARTMUS) under the THOR innovation program. The project was successful in reaching the preset technological goals and now awaits a Danfoss-driven decision on further development.
http://www.polymers.dk/research/posters/polymer_actuators.pdf

Two other public contracts: A national called "Bromfri" and an EU granted contract "INSULIN" holds strong industrial involvement Source Document: List of Contracts (SD6)

Commercial contracts

Name	Project leader	Length of contract	Type of Contract	Grants 2002 kkr	Market 2002 kkr	Total kkr
Mallinckrodt synthesis	Lizette Bruun	indefinite1	Commercial	0	800	n.a.
Chempilots	Lizette Bruun	02	Commercial	0	750	750
Cartificial A/S						
cartilage project	Klaus Bechgaard	01-02	Commercial	0	800	1200
Patent Roalties ect.	Kristoffer Almdal	not applicable	Commercial	0	200	n.a.
Smaller Commercial contracts	nn/Kristoffer Almdal	not applicable	Commercial	0	1638	n.a.

R&D contracts and Consultancies with industry (Commercial)

In addition to the above-mentioned Centre Contracts, the Polymer Centre collaborates with industry through specific contracts as well as through problem solving on an ad hoc basis.

Companies range from start-up enterprises to large corporations. Tasks include synthesis and development of new methodologies for analysis, to pure consultancies. In particular, the establishment of an advanced surface analysis facility has generated a very reasonable turnover with an expected commercial income in 2002 of several mio Dkr. In 2001 Risøs management granted extra 2 mio Dkr for an advanced MALDI-TOF, which became operational in May 2002.

Source Document: List of Contracts (SD6)

Patents

Polymer Centre staff members have generated 18 disclosures in the period 1999 –2002. These include 11 patent applications that have been filed and seven disclosures that await a decision on filing.

Patents and disclosures	Patents direct cost kkkr	License Income kkkr	Derived Full cost contracts kkkr*
1. Bates, F.S.; J.H. Rosedale; M.F. Schulz; K. Almdal: US patent, 5,955,546 (1999)	0	0	0
2. Batsberg Pedersen, W.; Berg, R.H.; Almdal, K.; Winther, L.: Tværbundet polyolefin substrat. EP application 94918770.0; US application 08/569.255	4	0	0
3. Bechgaard K, Jacobsen LD, Lauritzen JB, Olsen O, Batsberg WB, Steenstrup F, Vraae E. "Prosthetic device for inserting into joint cavity of vertebrate of human, comprises bio-compatible material containing first polymeric component with chain length longer than second polymeric component, AU200119964-A; WO200145595-A2	0	1064	3800
4. Horvath R.; N.B. Larsen; L. L. Lindvold; H. Pedersen, "Reverse symmetry waveguide biosensors", application filed, PCT	107	0	0
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10. Krebs FC ,Jørgensen M "New PPV Polymer" , Filed 19. march 2002	44	0	0
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15. Winther-Jensen, B.; West, K.: "Plasmapolymerisation".disclosure	-		
16. Hvilsted, S.; Ramanujam, P. S.: "Holografisk Smart Card".disclosure	-		
17. Larsen, N.B.; Lindvold, L.; Steensborg, J.: "Temperaturindikator".disclosure	-		
18. Berg. R.; Johannsen, I.; Jørgensen, M.; Spanggaard, H.: "Single molecule sensor. disclosure	-		
Total	516	1489	5500

*commercial value contracts

Start up companies utilizing Polymer Centre Patents

In 2001-2 three patents (SD7 no 5-7) licensed or transferred to Optilink A/B, <http://www.optilink.dk/> are under commercialisation with participation from the Polymer Centre.

In return for patent rights (SD7 no 3) transferred to Cartificial A/S <http://www.cartificial.com/> the Polymer Centre (at Risø) has received stocks in accordance with new governmental regulations. At the same time Risø works under contract with Cartificial A/S to develop the patented materials into registered devices. (Turnover in 2001-2 amounts to 3.8 mio Dkr)

Financial result:

Patenting costs direct	-516 kkr
Licences and value of received shares paid to Risø	+1489 kkr
Net profit	973 kkr

In addition 5500 kkr has been paid from the above mentioned companies at full commercial rates for R & D contracts (Estimated net profit at least 30 %)

Source Document: List of patents and disclosures. (SD7) List of Contracts (SD6)

Industrial Forum-MODECS

MODECS stands for "Molecular Design of Chemical Systems" and is a forum in which institutions and industries meet for exchanging ideas and making informal contacts. Many major Danish chemical industries and research institutions are members. The Polymer Centre manages the Modecs Forum. <http://www.modecs.dk/>.

Project Pilots

The procedure for contacting the Danish Polymer Centre with respect to specific assignments has been facilitated by the decision to employ two Project Pilots; (i.e., commercially minded personnel with scientific backgrounds within research, development and processing and with experience in project management). Often it is an advantage for the company to have only one contact person and the Project Pilots act as task or project managers at the Polymer

Centre on behalf of the company. This initiative constitutes a new way in which small or medium-sized companies can easily make inquiries about practical problems or research projects. This initiative has been very well received by industry. The two project Pilots: Sune Lund Jensen and Hasse Buus are formally employed at Risø. Sune Lund Jensen has effective September 1. accepted a job as R & D manager in Cartificial A/S.

Courses for industrial graduates

The Centre will offer two one-day courses for industrial graduates in the fall of 2002.

Titles are: "Two-component injection moulding" and "Rheology" and, in addition, an advanced course dealing with "Polymer surfaces" is planned for early 2003.

NEW DEVELOPMENT INITIATIVES 2002 –

- EU 6th framework program
- Nanotechnology facility at Risø (CleaR) and Research Professorship with University of Southern Denmark
- ESS initiative (neutron scattering)
- New initiatives in education
- New initiatives towards industry
- Other new initiatives in research

The most recent general description (2001, in English) of the Danish Polymer Centre is found in the Brochure "The Danish Polymer Centre" (SD8) which describes the current expertise and the experimental facilities.

As this assessment is written (July 2002) the Danish Polymer Centre is in a transitional period. New statutes are being negotiated between DTU and Risø and a new Centre Director shall be appointed following an international call for applications (deadline Sept. 30 2002). Thus no definitive plan for the future direction can be presented because the new Director shall have the possibility to set his/her mark on the planning.

However, it is reasonable to assume that the four focus areas which have been developed over the past three years will continue since the Centre's main competences lie within these areas and because the experimental facilities have been developed along these lines of research.

The potential new developments described briefly below are in a first phase but it is believed that these new initiatives will form a basis for the future developments at the Danish Polymer Centre.

EU 6th framework program

Researchers at the Polymer Centre have participated in the writing of proposals for more than 10 network and integrated projects under the pre-qualification for the 6th framework programme. As this report is written (July 2002), answers have yet to be received from the European Commission.

Nanotechnology facility (CleaR) at Risø and Research Professorship with the University of South Denmark

A new large clean room facility (150 sqm.) and adjoining laboratories designated for work with polymers and biological applications (organic nanotechnology) is planned at Risø with participation from several departments. If the

30 mio Dkr project is approved by Risø's Board in September 2002 the laboratories will be operational in April 2003. In connection with this project a research professorship with the University of Southern Denmark has been negotiated.

ESS initiative

Researchers at the Polymer Centre are active in the planning of the European Spallation Source (ESS). Their contributions can be found at <http://essnts.ess.kfa-juelich.de/TheESSProject/> VOL II p 6-37 and VOL IV p.2-36.

New initiatives in education

The major new initiatives are the International Master's and PhD school. Negotiations are also underway with the University of Lund to establish synergy in advanced courses and to exchange students. Regular visits take place between DPC and Lund at six-monthly intervals.

New initiatives towards industry

DPC will expand its activities in postgraduate education by offering one and two day specialized courses and DPC regularly arranges seminars and symposia (see www.polymers.dk for upcoming events). Recently two companies have decided to move instruments to DPC in a shared facility. NKT Research has transferred a SEM and Coloplast A/S has transferred a Rheometer to DPC. Also the CleaR facility described above will be available for industrial prototype production.

Other research initiatives

The above-mentioned CleaR facility will improve the Polymer Centre's process capabilities. In particular the structure fabrication compartment will enable DPC researchers to fabricate and analyse polymer prototypes down towards the nanometer scale. This will give the ongoing and future research in bio-related surfaces, plastic solar cells, polymer semiconductors and polymer actuators unique possibilities.

Also researchers from the Centre are engaged in an intensified activity related to polymer-composite interfaces (with Danish industry) and in an increased activity in biocomposites.

Recently new efforts in polymer synthesis have focussed on the preparation of fluorine containing block copolymers with the aim to obtain new functionalities with improved surface, optical and electronic properties.

Finances (2002)

DTU and Risø National Laboratory operate under different financial models. At DTU, a number of permanent positions with small operating budgets are allocated to the departments in return for contractual obligations to deliver specified courses. Any external research contracts are tolled with an overhead of 20 % (except in the case of the STVF contract under evaluation where activities allocated at DTU are charged an overhead of 3 %)

At Risø, a particular base funding, unrelated to the number of permanent positions is allocated to the Polymer Department and an overhead (per capita and space requirements) is returned to cover administrative costs, buildings and a central investment fund.

We have therefore generated an overview of the total economic activity related to the Danish Polymer Centre in 2002 by "charging" the permanent staff salaries at DTU with an overhead of 100 % as an estimate of the value of administration, buildings and central research funds at DTU.

Total budget for the Polymer Centre 2002

	2002, kDkr
DTU base funding (perm. staff salaries + 250kDkr)	5150
+ Virtual overhead value	
(+ 100 % on permanent salaries)	4950
Risø base funding	16235
Extra central funds Risø	3213
Polymer Centre Research contracts incl. overheads	13631
Commercial contracts	5018
STVF, DPC funding incl. overheads	7500
Total turnover	55697
Overhead, paid to DTU	660
Value of virtual overhead (100 % on permanent salaries)	4950
Overhead, paid to Risø	8053
Total Net turnover	42034

STVF Polymer Centre grant

The central grant was given as 10 mio Dkr directly to DTU for construction of the Centre facilities. 30 mio Dkr was given as a general research grant for investments and research for 4 years (July 1999 to July 2003) with a small overflow into 2004 for PhD stipends.

The total 30 mio budget incl. overheads (all in kDkr):

	Budget (1999-2003)	% Breakdown	Ultimo2001 (2.5 years)	Budget 2002-3 (1.5 years)
Investments in equipment and running cost of equipment	7450	24.8	6850	600
National collaborative PhD stipends* with AaU and ÅU	1920	6.4	1920	0
16 DPC research projects incl 8 DPC fully financed PhD stipends*	16970	56.6	7575	9395#
Education and Dissemination of results	720	2.4	670	50
Administration and running costs	2940	9.8	2166	774
Total	30000	100	19181	10819

* Average cost of a PhD stipend incl. 20 % overhead is 1500 kDkr

Breakdown of research budget 2002-2003 (1.5 years) 9395 kDkr

Designated salaries for PhDs* and post docs	6867 kDkr
Running costs	2528 kDkr
Total	9395 kDkr

*Several PhD stipends will terminate in 2004

STAFF

Faculty

Almdal, Kristoffer	Programme Head, Risø
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Lynggaard, Berit	IPL
Schlichting, Bente Overgaard	Risø
Thomsen, Alice Kirsten	Risø

KT: Department of Chemical Engineering

IPL: Department of Manufacturing Engineering and Management

List of source documents

SD1	Statutes (in Danish)
SD2	STVF grant application (in Danish) called "Bilag 1"
SD3	Activity report The Danish Polymer Centre 1999/2000
SD4	The Danish Polymer Centre Annual Report 2001
SD5	List of refereed publications with citations
SD6	List of contracts
SD7	List of Patents and disclosures
SD8	"The Danish Polymer Centre" 2001.

Danish Polymer Centre Journal articles 2002

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