Appendix E. Strategic Plan

Introduction and Background

The purpose of the strategic plan is to focus all Center programs around key technical and social domains which support our vision: sustainable technology. Every activity within our Center should support our vision in a clear, unique way while being fully integrated with other Center activities. Our multi-disciplinary organization leverages diversity and understanding of social dynamics to realize the vision of the Center. These interactions are illustrated in Figure E1

Technical domains (Macromolecular Synthesis and Engineering; Functional Materials and Devices; Nanostructures, and Separations) are represented in the icon by interlinked circles, indicating that technologies of each area are interdependent. Technical thrusts and conducted against a background of inter-related social programs that seek to further long-term technical goals. Four social domains (Leadership, Knowledge Exchange, Diversity and Education) represented by the square background, address the "social dimensions" of innovation. Our Innovation Process Research Program, represented by the circumscribed circle, supports these social domains. By understanding fundamentally what drives successful behavior in these key areas we hope to facilitate interdisciplinary research and the innovation process.

The strategic plan is intended to establish direction and provide alignment, not to provide a roadmap set in concrete. It is updated annually and allows for flexibility, within limits. Both the product and the process are important. The direction that the Center takes over time results from hundreds of individual decisions. Thus, it is important not only to establish the right direction with our strategic plan but also to get everyone's understanding, input and commitment. We develop our strategic plan as a cascade process. As the plan is being developed or revised, draft versions are "cascaded" throughout the Center to assure that everyone understands and has opportunity to input to the plan. Having agreed to the final plan everyone is expected to make decisions and take action aligned with it.

Strategic planning is a cascade process on a second level as well: each step is linked to the preceding one with shorter range, narrower focus and greater detail. The process proceeds through vision→mission→goals→objectives (VMGO). Performance measures are developed in each of the five areas shown on our icon (all research thrusts are taken together for reporting purposes). Planning began in 1999 with analysis of needs that supercritical fluids technology might address. We identified the barriers which separate us from the future to which we aspire. The need for sustainable *"green"* chemical processes was identified, leading to a vision reflecting the difference we hope to make.

Current Strategic Plan

Our vision is to enable a revolution in sustainable technology through cutting-edge, integrated physical science/engineering; social science; and educational programs. A *"revolution in sustainable technology"* captures the visionary part of this statement. Revolution implies risk. We purposefully undertake the type of high-risk/high-reward (*high impact*) research that industry increasingly avoids. Our vision and mission are meant to endure the life of the Center and beyond.

Our statement of mission describes, at a high level of abstraction, the means we use to overcome barriers and achieve our vision. By including social processes, education and diversity in our mission statement, we mean to state unequivocally that these are as important to the ultimate success of our Center as technology; they are not "add-on" elements. Our mission is to:

- Support multi-disciplinary, fundamental research to identify and enable sustainable processes and products using CO_2-related technologies
- Enable our science and technology to have broad societal benefit by understanding and applying social processes that foster collaboration, innovation and action; by attracting and educating diverse students at all levels; and by promoting the benefits of sustainability.

"I*dentify and enable sustainable processes and products"* means that we plan for and target our fundamental, cutting-edge science to have practical applications. *"Sustainable"* implies environmentally benign, energy efficient and economically competitive. *"CO_2-related technology"* describes the focus of our cutting edge science and engineering.

Technical Domains While our research focuses on fundamental understanding, our overarching technical goal is to identify and demonstrate feasibility of sustainable processes, materials, and devices as candidates for further development. Domains are selected by our Technical Coordinating Committee (TCC) based upon TCC assessment (with input from our industrial affiliates) of (1) where our technology can have maximum impact and (2) where potential exists for strong market growth for applications of our "green" technology. Our strategy is based upon the assumption that new technology is more readily accepted in emerging, high-value areas. Here rapid development and growth with changing technology are the norm. Acceptance of new technology in these areas is more likely than in commodity areas where investment is imbedded and growth slow. Details of the current plan are given below; specific projects listed in Table E1. The interlinked circles on our icon represent current technical domains and indicate that each area supports all of the others. For example, projects in Macromolecular Synthesis and Engineering provide polymers for those in Functional Materials and Devices. Meniscus coating studies in Functional Materials and Devices supports self-assembly studies in Nanostructures. Understanding of surfactant properties in Nanostructures supports developments in Macromolecular Synthesis and Engineering. Technology developed in Separations supports all other technical domains as economical recovery and recycle is a key to commercial success.

In general we employ a strategy of time-sequencing: "open, narrow, close, open". There is no specific period for these stages, but each is generally about two years (corresponding to the usual funding period). And most projects will go through them. At any given time projects in the Center may be in any of the three stages. (See Table E1 as an example.)

During the initial "open" phase thinking is divergent as we seek to build broad fundamental understanding and develop necessary tools and facilities in a given field. We try to avoid pre-conceived notions of what is or is not important. Later, with input from various "knowledge exchanges" and our own scouting activities, we narrow our focus to specific areas that appear promising. In the "close" phase we prepare for transition. Projects may be closed if no additional fundamental studies are required. If the work has identified a potential commercial target(s) "close" may mean terminating STC-funded fundamental work in favor of sponsored research. If no sponsor is found "close" may mean literally shutting down the project or modifying the focus based on external factors. Projects may be closed due to a change of tactics in support of our strategic plan. They may also be closed if annual review by the TCC decides that we aren't leaders in the area as in the case of small molecule catalysis and biotech projects, where we lacked critical mass to lead. In the renewal process, however, closing of one project leads to opening of another, following leads developed during that initial project. This is the key mechanism by which CERSP continually renews itself in order to remain dynamic and remain at the frontier. In establishing new projects the key determinant is adherence to our strategic plan, especially vision and mission.

Social Science Domains The second part of our mission *"enable our science to have broad societal benefit by understanding social processes that foster collaboration, innovation, and action"* reflects our belief that technology alone is insufficient to achieve a revolution.

People, not just technology, effect change; thus our social programs are keys to the long-term success of our Center. These programs include exchanges, workshops and scholarly studies that are also of immediate value within the Center. They encompass all four social domains shown on our icon. The Innovation Process Research Program contributes to

- *leadership*: study of successful leadership qualities among directors of NSF-sponsored centers and tools to improve such qualities; and a leadership workshop for students
- "*knowledge exchange*": study of factors contributing to success or failure of industrial consortia, development of cross-disciplinary text-mining tools, and an innovation workshop
- *diversity*: study of factors contributing or hindering HCBU/Research I cooperative research, a pilot program regarding possible role of African-American churches in outreach, and a multi-dimensional mentoring/scholarship program aimed at recruiting African-American students into STEM graduate programs
- *education*: study of factors contributing to student success within NSF-sponsored centers

Leadership is a key factor in "*action*" or implementation. Understanding the innovation process, including social processes of research collaboration, are key components of leadership. Improving the leadership skills of Center participants, from students to the Director, facilitates our *current* research, as well as providing long-term benefits. Further, to effect a "revolution in sustainable technology" will require a new generation of students. Our students will need not only the technological skills but the leadership skills (with the resultant courage, self-confidence and political sensitivity) to lead this revolution. Our academic study of successful leadership qualities and feedback mechanisms for complex, multi-dimensional research should improve operations in current and future NSF centers, including our own.

Within the Center our leadership plan is to employ a few key operational structures to implement our strategic plan. The management team has made clear the need for integration of all aspects of the Center. We employ Center-level, site-level and thrust area-level leadership teams to coordinate all Center activities. Our vision requires that our work have great impact. We choose our projects carefully to have that impact. Projects must provide technical leadership or they will not be funded. If we cannot be among the leaders in a particular area, we will redeploy resources to areas in which we can.

Effective "*knowledge exchange*" is required for successful implementation of our technology. We prefer that term rather than more commonly used terms "technology transfer" or "knowledge transfer". "Exchange" implies continual communication on multiple fronts. It involves all of our constituencies: scientists, students, industry and society—directly and via our External

Advisory Board, which we use extensively. Most technical exchange is among academic and industrial researchers, but as appropriate we also involve development boards, legislative and regulatory bodies, venture capitalists, etc. We need their input and seek to make them allies in our "revolution". "Exchange" implies on-going co-operation, not "*fait accompli*" communication of plans.

Exchange with industry remains critical, including constructive criticism of our research, market information, and supply of materials and research technology not generally available. Our industrial affiliates program requires minimal contribution by participants. We use this funding to improve information dissemination by frequent direct exchange with industrial scientists rather than using it to fund supplemental research. We anticipate that improved dissemination will result in more meaningful collaborations, with fewer but larger research contracts. These contracts will aim at strengthening specific technology of commercial interest by focusing on thematic, one-on-one projects between Center researchers and individual companies.

Large chemical companies are becoming increasingly dependent upon investing in startups as a way to acquire new technology. Thus, we will involve more entrepreneurial and venture capital organizations in knowledge exchange activities. While our target audience may be broadening somewhat, our role in the innovation process is unchanged. We seek to advance the frontiers of science, to enable, and to catalyze change. We "develop" only to the extent necessary to advance science; e.g., by developing tools for specific experimentation.

Exchange has been and will continue to be accomplished by many means: shared facilities, papers (especially joint), industrial affiliations and "sabbaticals", licensing of IP, symposia, surveys, presentations in a wide range of conferences and forums (technical and non-technical), newsletters, articles in the public press, museum exhibits, continuing education courses, etc.

Diversity is an integral dimension of our Center—not only diversity in race and gender but diversity of thought, skills, and discipline. In our view diversity is a driver that can accelerate successful innovation. While brilliant ideas come from individuals, innovation requires diversity. We seek to elicit the benefits of diversity by recognizing differences and providing communication skills to bridge and capitalize on differences. We study past HBCU/Research I collaborations in order to identify factors for success or failure. We seek and support diverse populations at all levels—from K-12 students to faculty to members of our External Advisory Board. While we "count" extensively, more importantly we seek ways to increase diversity in the pool of scientists and engineers entering graduate schools.

Education at all levels is important to achieving our Center's long-term vision. We extensively leverage existing programs and resources to increase impact, including K-12 programs at Science House and various outreach programs at all universities. We demonstrate to large numbers of K-12 students that hands-on science is fun. In addition we teach that sustainability is a serious issue that they can do something about. Societal "buy-in" is required for innovation, especially in generating the "pull" for green technology. Our intent is not only to recruit a new generation of scientists but to help educate a new generation of citizens regarding the environmental impact of modern society and the necessity of sustainability. And by participating in these "outreach" activities our students hone their own understanding and communication skills.

At the undergraduate, graduate and post-doctoral level we seek to provide a broader experience for students than is typically available in higher education. We have examined the literature to identify perceived short-comings in engineering and scientific curricula and seek to fill those gaps with our enhancement programs. The leadership workshop mentioned above is one of those programs, as are our programs in entrepreneurship, innovation, safety and mentoring.

Research Program Evolution

Having identified barriers and established a vision and mission, we initially defined “thrust areas” with shorter term goals supporting our vision. Thrust areas were defined so as to have greatest impact in overcoming key barriers. Specific projects were developed to achieve these shorter term goals. We update our plan annually, consistent with our initial vision and mission. While our vision and mission have changed little, objectives, goals, domains and/or performance measures change periodically. This evolution is driven both by our discoveries—growing recognition of the capabilities of our technology—and external factors. We are currently on our fourth set of “thrust areas” or “domains”. We now use the term “implementation domain” to remind ourselves that the eventual goal is commercialization of technology that we develop.

While the ”open-narrow-close-open” approach described above under ***Technical Domains*** is the norm, we are flexible. For example, in our Renewal Proposal we identified “Microelectronics” as a major new implementation domain, anticipating transition of the industry to 157nm irradiation technology. When the industry leader, Intel, dropped 157 nm programs so did many other companies who had invested hundreds of millions of dollars in 157nm lithography. Several months down this path we revised our strategic plan (to the one described herein) reflecting this reality. Microelectronics was broadened to become “Functional Materials and Devices.” Several projects were redirected within months of their start, but without significant loss of momentum or student research time. For example, our efforts in photovolatics emerged as part of this retooling.

This recent foray into and out of microelectronics is consistent with our strategy outlined above. The *strategy* was appropriate, but our understanding of industry structure was flawed. While processes evolve rapidly (fitting our strategy), the underlying technology is firmly embedded. A frontal assault across the entire range of process steps to “revolutionize” the industry is too expensive and not supported by industry. Rather than trying to displace incumbent technology broadly, we have now decided to focus on a few steps with higher probability of success.

Importantly, facilities and technical developments made in pursuit of microelectronics were readily applied to developments in both Functional Materials and Devices and Nanostructures. Rather than closing the “Microelectronics Domain” entirely, we have widened its view to related topics applying similar technology not directly associated with microelectronics. For example, studies in photolithography have lead to discovery of “soft lithography” capable of replicating nanostructures and to technology that might be applicable to fuel cells. Both of these areas fall within our vision and mission. Meanwhile, we continually seek other applications for technology derived from emerging studies in our laboratories. This expansion will continue as we seek to enhance our legacy. (See below, Legacy Enhancement Planning.)

Social science programs have gone through one cycle of evolution. Our early focus on collaboration was appropriate initially as we needed to develop tools and skills for remote collaboration. We have reconstituted our social science research as the Innovation Process Research Program. It encompasses all aspects of “Social Domains”—leadership, “knowledge exchange”, education and diversity—in an effort to understand how these factors can facilitate the Center’s multi-disciplinary research and the innovation process: e.g., in taking technology to commercialization. These projects are selected not only to be excellent stand-alone academic work but to provide real time information useful for ongoing Center operations.

Legacy Enhancement Planning

As we approach the "sunset" of CERSP and begin planning in earnest for its legacy we have adopted a four step process designed to enhance our legacy: (1) Define the overarching objective of our "legacy enhancement process", (2) Identify resources available for that process, (3) Select areas to explore via a series of workshops and (4) Select projects to fund.

Overarching Goal During the first seven years of CERSP we have focused on fundamentals as stated in the first section of our research plan (*vide infra*, Strategic Synopsis):

- Develop fundamental understanding of
    - Macromolecular synthesis and engineering: kinetic and transport mechanisms, thermodynamics, phase equilibria; factors affecting polymeric structure of materials and function in CO_2-related systems, including catalytic and post-polymerization processes
    - Nanostructures: beneficial properties of supercritical CO_2 that enable control of synthesis, stabilization, deposition and self-assembly of nano-scale structures
    - Functional materials and devices: phenomena involved in dissolution and removal of materials, formation of thin films and coatings, dimensional control of structures, and photochemical conversions
    - Separations: phenomena specific to separation science and technology needed for CO_2 processing

We believe that ongoing CERSP projects established under this first section have set up the Center for a strong legacy. For example, commercial interests are already developing early leads for CO_2 cleaning developed in part under CERSP that are expected to have important impact in manufacturing microelectronic components. That is now self-sustaining.

We believe that in the waning years of CERSP we should invest a substantial portion of remaining funds to investigate specific opportunities to enhance that legacy by focusing more on the second and third sections of our research plan; that is:

- Integrate fundamental understanding in these areas [*vide supra*] to demonstrate processes for functional materials; e.g., for electronic, optical, energy and therapeutic applications

in order to identify and demonstrate feasibility of sustainable processes, materials, and devices as candidates for further development.

- Explore new frontiers in relevant basic science in order to identify new areas for application of sustainable technology

For example, CERSP funds were largely responsible for discovery of the underlying science of the PRINT (Particle Replication In Non-wetting Templates) process. PRINT offers the potential to replicate structures with sub-nanometer resolution using organic polymers with tailored characteristics. PRINT has already contributed to two major ($35 million) new NIH research initiatives in cancer research. Following this example the overarching goal of our legacy enhancement planning is to identify areas where leads developed under CERSP can be extended consistent with our strategic plan. We anticipate developing proposals for other multi-year, multi-disciplinary, multi-institutional projects. To simplify this process we have decided to focus on the UNC-Chapel Hill/NC State axis as the core for developing new proposals. UT-Austin will develop its own plan.

Resource Availability To identify those opportunities we continue to use the “open, narrow, close, open” sequence described above. During Year Seven (2006) we began to prepare for our final renewal. We have sought to identify projects that can be closed so as to identify openings for potentially impactive projects in areas which are extensions of existing successful work. The first step was to develop a matrix for 2006-2009 showing which projects would be ending and when. As guidelines the Technical Coordinating Committee (TCC) considered the expected impacts of current projects as well as forecast completion schedules for graduate students and post-doctoral associates. TCC then determined the number of “slots” available at UNC-CH and NC State in each year, taking into account reduced funding in 2008 and 2009 (80% and 64% funding respectively). Determination of resources available is Phase 2 of our plan.

Areas to Explore In Phase 3 TCC selected focus areas based upon our strategic plan then set out to determine which projects to fund to fill those slots at each school via a series of workshops. Areas selected for study through workshops include: (1) Nanotechnology in Medical Sciences (Therapeutics and Diagnostics), (2) Sustainable Energy Alternatives (SEA), (3) Separations Science, (4) Leadership in Innovation and Entrepreneurship. (5) Nanotechnology for Breakthroughs in Sustainability (including health effects of nanoparticles), and (6) Biotechnology. The first four topics are already being explored within CERSP, but at a modest level. Topic (5) also includes consideration of how to utilize the Triangle National Lithography Center more effectively in nanotechnology development. Topic (6) is one that we explored early in CERSP but dropped for lack of critical mass. In view of the State of North Carolina’s agricultural base and its investment in biotechnology in the Triangle area as well as opportunities in therapeutics and for biomass for energy alternatives we decided to include this topic. The underlying theme in all of these topics is sustainability.

We are conducting a series of workshops in which we are inviting "leading lights" in these six fields of interest to speak. Following these initial seminars we plan "brainstorming" sessions among our invited speakers and other STC faculty to identify areas for developing future major proposals. Any proposals will likely involve UNC-CH and NC State and possibly other schools in the Triangle area. The final phase, *Project Selection*, will be conducted in Fall 2006, essentially setting our program through CERSP’s sunset in 2009.

Strategic Synopsis

The following “strategic synopsis” summarizes our current strategic plan, including vision, mission, goals, objectives, performance measures and research program plan for 2006-2007.

Vision, Mission, Goals, Objectives and Performance Measures

Vision and Mission

Our vision is to enable a revolution in sustainable technology through cutting-edge, integrated physical science/engineering; social science; and educational programs.
Our mission is to

- Support multi-disciplinary, fundamental research to identify and enable sustainable processes and products using CO_2-related technology
- Enable our science and technology to have broad societal benefit by understanding and applying social processes that foster collaboration and innovation; by attracting and educating diverse students at all levels; and by promoting the benefits of sustainability.

Goals, Objectives and Performance Measures

- Research Objectives
  - Develop fundamental understanding of
    - Macromolecular synthesis and engineering: kinetic and transport mechanisms, thermodynamics, phase equilibria; factors affecting polymeric structure of materials and function in CO_2-related systems, including catalytic and post-polymerization processes
    - Nanostructures: beneficial properties of supercritical CO_2 that enable control of synthesis, stabilization, deposition and self-assembly of nano-scale structures
    - Functional materials and devices: phenomena involved in dissolution and removal of materials, formation of thin films and coatings, dimensional control of structures, and photochemical conversions
    - Separations: phenomena specific to separation science and technology needed for CO_2 processing
  - Integrate fundamental understanding in these areas to demonstrate processes for functional materials; e.g., for electronic, optical, energy and therapeutic applications

in order to identify and demonstrate feasibility of sustainable processes, materials, and devices as candidates for further development.

  - Explore new frontiers in relevant basic science in order to identify new areas for application of sustainable technology
  - Develop fundamental understanding of key factors impacting leadership, knowledge exchange, education and diversity in order to facilitate the innovation process

- Research Performance Measures
  - Number of peer-reviewed publications in professional journals
  - Presentations at major professional meetings, invited lectures and seminars, etc.
  - Complementary funds attracted
  - Effective utilization (and sharing) of facilities
  - Number of effective tools to facilitate cross-disciplinary research

Education Objectives

- Improve the educational process at all levels to provide a new generation of students with technical and leadership tools to support and implement "green chemistry".
- Enhance K-12 students' and teachers' knowledge of science and engineering, the importance of collaboration and how these fields contribute to a cleaner environment, through curriculum development, classroom visits, and teacher workshops.
  - Promote higher education in science with a specific goal of reaching under-represented students

    - Develop service-learning course as a means to mentor “at risk” students

in order to build broad societal support needed for implementing sustainable processes

- Provide a more comprehensive educational experience of STC students, giving students tools which enable them to
    - develop more effective skills in communication and collaboration
    - develop leadership skills that they can practice and hone while students
    - develop appreciation for entrepreneurial opportunities afforded by new technology and skills needed to follow through to commercialization
    - apply “each one teach one” concept of peer-to-peer and student-mentor training
    - interact effectively with K-12 students and thus
        - improve their ability to communicate complex concepts simply
        - develop creative means to involve students in a low-risk environment
        - provide K-12 students with exposure to scientists as role models

in order to produce effective scientific leaders and advocates of sustainable technology

- Develop mechanisms to provide continued funding for educational programs after sunset of CERSP in order to institutionalize programs and preserve the gains made

➢ Education Performance Measures

- The numbers of undergraduate, graduate and post-doctoral associates advised
- Number of students graduating and placed in professional positions
- Number of students publishing and presenting papers
- Number of students receiving awards
- Number of students participating in enhancement activities (Personal Development Program)
- Numbers of teachers and K-12 students reached
- The number of training modules produced and disseminated
- Written evaluations by teachers of curriculum materials and teacher workshops
- A database documenting impacted teachers and number of students
- The number of CERSP students and faculty members involved in outreach
- Documented performance improvements in Center students vs. non-Center peer group

➢ Knowledge Exchange Objectives

- Establish multi-dimensional communication pathways by which
    - knowledge developed in the CERSP can be efficiently transferred to those who will implement it and/or benefit from it, both within the commercial sector (including ongoing operations and the venture capital community) and the educational sector
    - the views and needs outside the CERSP are factored into our plans
    - governmental agencies are apprised of our accomplishments, plans and needs
    - public support is maintained by informing citizens and getting feedback regarding the implications and importance of CERSP work
- Leverage resources of the Center to
    - establish individual and organizational partnerships
    - provide facilities enabling development of CERSP-invented technology

in order promptly to convert technical knowledge into successful, sustainable processes and enterprises enjoying public support

➢ Knowledge Exchange Performance Measures

- Exchanges with industrial and entrepreneurial affiliates and government officials, Center-sponsored symposia, workshops, and use of facilities for knowledge exchange
- Dissemination of information via CERSP Newsletter and website
- Number of papers published and presentations at professional meetings
- Number of invited presentations
- Patent donations, filings, acquisitions and other intellectual property management
- Personnel exchanges, number of visiting scientists and number of joint papers
- Complementary funding attracted from industry
- Number and quality of external collaborative interactions
- Number and quality of international interactions

➢ Diversity Objectives

- Encourage members of underrepresented groups (URG) to seek and succeed in research careers in science and engineering by focusing on K-20 outreach, mentoring and recruiting efforts
- Enhance the support network for URG students on CERSP campuses
- Provide students and faculty with tools to recognize, understand and employ diverse styles in order to help build a diverse workforce and harness the power of diversity to accelerate and enhance the innovation process

➢ Diversity Performance Measures

- Number of URG students contacted and participating in CERSP-sponsored events
- Number and percentage of URG students participating in internships
- Number and percentage of URG students and PIs participating in CERSP
- Number of CERSP participants involved in diversity-enhancing activities
- Number and percentage of URG students entering graduate programs, employed as scientists and engineers
- Number of strategic alliances with national networking organizations devoted to URGs
- Number of connections with HBCUs as measured by lectures and exchanges
- Number of students entering and retained in EXPERT program

➢ Leadership Objectives

- Develop and apply fundamental understanding of social processes fostering collaboration, innovation, and action in the CERSP in order to empower individuals to reach career goals while furthering the organization's scientific, technological and educational goals
- Study, develop, improve and apply leadership skills of CERSP participants at all levels in order to enhance effectiveness of Center operations

➢ Leadership Performance Measures

- The number (and percentage) participating in our Personal Development Program
- Review and apply tools developed by social science program
- Annual review and revision of strategic plan
- Annual review of performance vs. management indicators in all areas

Table E.1 2006-7 Research Projects
Macromolecular Synthesis and Engineering
Leader: Roberts NCSU

Polymerization
Continuous homogenous polymerization Roberts
Initiator decomposition kinetics Roberts
Thermodynamic measurements Kabadi
Calorimetry of macromolecules in CO_2 Kabadi
C8-Free Methods of Making Polytetrafluoroethylene# DeSimone
Alternative fluorinated materials to PFOA# DeSimone
H+ super-conductive materials DeSimone
Preparation of Tunable Biodegradable Elastomers# Ashby
Kinetics of Polymerization and Motional Studies# Samulski
Swelling and crystallization of homopolymer and diblock copolymer thin films is sc CO_2 Green
Polymer Welding with $C0_2$ Sanchez
Catalysis
Metal catalyzed reduction of C-X Brookhart
Post-polymerization hydrogenation Roberts
Lipase catalysis in $scCO_2$: stability and activity# Roberts
Polymer processing
Plasticization of FP at high temp and press: NMR Samulski

Functional Materials and Devices
Leader: Parsons NCSU

Dry film processes
Annealing of organic films Irene
Impregnation of pharmaceuticals into polymers Carbonell
Anomalous swelling of thin films Sanchez
Lithographic Processes
Processing photoresists# Carbonell
Fundamental surface studies of lithographic materials# DeSimone
Triangle National Lithography Center Osborn
Deposition
Dielectric deposition Parsons
Metal film deposition Parsons
Reactive deposition of metal and ceramic films K. Roberts
Etching/dissolution
scCO2/HF Etching of dielectrics Irene
QCM : deposition/dissolution rates Grant
Optical methods to monitor dissolution Genzer
Sustainable Energy Alternatives
Degradation processes in membranes Forbes
High surface area, highly conductive membranes # DeSimone
Photovoltaics using PRINT # Templeton

Nanostructures

Leader: Johnston UT-A

Synthesis and stabilization

Diffusion & electron transport Murray
Polymer filled nanocomposites Khan
Kinetics & transport in particle formation in SEDS Carbonell#
Intercalation of polymers Samulski
Peptide folding in supercritical CO_2 # Waters
Synthesis, stabilization, and separation of nanocrystals Korgel
Surfactants for nanoparticle assembly Rossky
Thin film nano-crystal composites Green

Self-Assembly

Controlled self-assembly of functional particle coatings Velev
Nano self-assembly patterned surfaces Johnston
Nano self-assembly solid substrates Korgel

Applications

Biosorbable particles using PRINT# DeSimone
Magneto-Polymer Particle Fabrication Using the PRINT Technique# DeSimone
PRINTing Electroluminescent Polymers # Samulski
Computational modeling of surfactant-inorganic materials recognition Rossky
Composites of Pre-Synthesized Nanocrystals in Porous Media Johnston
Nanoparticles for high bioavailability Johnston
CO_2 Based Emulsions: Fundamentals and Applications Johnston

Separations

Leader: Koros Georgia Tech

High zeolite-polymer hybrid Koros
Zeolite-solvent-resistant polymer hybrid Koros
Carbon-polymer Koros
Mesoporous ceramic membranes Ilias

Projects completed or redirected in 2006

Rheological studies of PVDF Khan
Solution properties: Theory Rubinstein
Solution properties: SALLS, DLS DeSimone
Chemical Mechanical Planarization process studies Carbonell
CO_2-Modified development and post applied bake Carbonell
Deposition of thin films Carbonell
Soft lithography (morphed to Fundamental Surface Studies) DeSimone
Polypeptide microemulsions (morphed to Peptide Folding) Waters

Colors indicate lead schools: UNC-CH, NCSU, UT-A, GaTech and NCA&T
 # New projects started in FY2006
Italics indicates completed or redirected projects

2006-7 Social Science Research Projects

Leader Denis Gray

Leadership

Successful leadership qualities in Cooperative Research Centers^—Craig

Leadership workshop—Osmond

Knowledge Exchange

Factors that predict a firm's decision to join university-based industrial consortia^—Gray

Development of cross-disciplinary text mining tools^—Blake

Colors indicate schools: UNC-CH and NCSU

Diversity

Factors affecting success of HCBU/Research I research partnerships^—Gray

SRMSI: Mentoring of "at risk" students—Martin

Education

Analysis of factors affecting graduate student satisfaction and performance in Centers^--Gray

^ Projects completed during FY2006

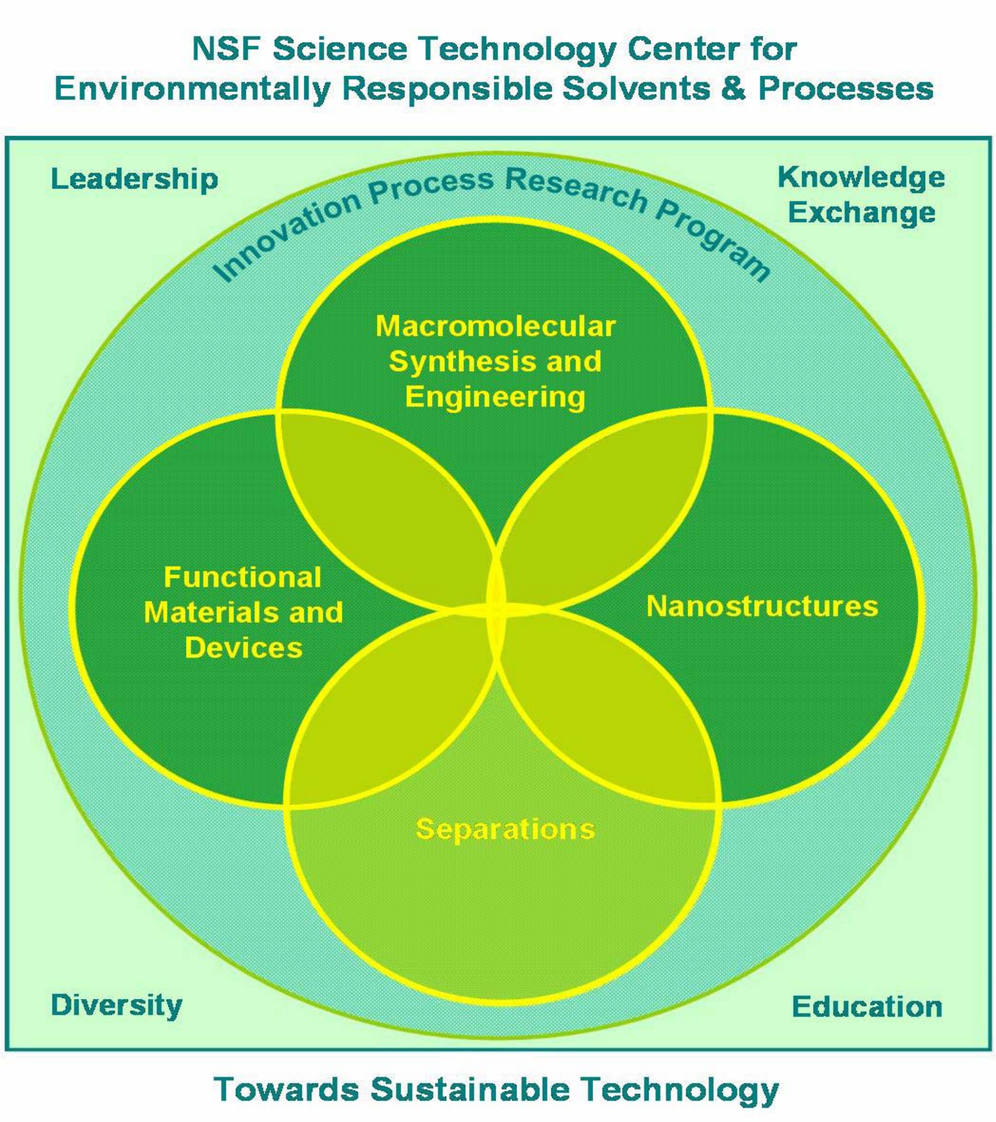

Figure E1. Icon Summarizing CERSP Activities