

**DEVELOPMENT AND VALIDATION OF NEUTRON-BASED CHARACTERIZATION  
METHODS FOR MORPHOLOGY AND TOPOLOGY OF SOFT MATERIALS  
COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENT  
BETWEEN  
MEMBER NAME  
AND  
THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY**

Article 1. **INTRODUCTION**

The National Institute of Standards and Technology (NIST), agrees to supervise and administer on behalf of **MEMBER NAME**, hereinafter referred to as the “Member,” and all other Consortium Members, *Development and Validation of Neutron-based Characterization Methods for Morphology and Topology of Soft Materials* Consortium Cooperative Research and Development Agreement (CRADA).

Article 2. **DEFINITIONS**

As used in this CRADA, the following terms shall have the indicated meanings:

- 2.1 **“Background Invention”** means any Invention of NIST or the Member conceived outside of this CRADA.
- 2.2 **“Consortium”** means NIST and the Consortium Members and their actions with respect to the Program.
- 2.3 **“Consortium Member(s)”** means an entity, including Member, who has entered into an agreement with NIST that includes terms materially the same as or identical to the terms of this Agreement.
- 2.4 **“Cooperative Research and Development Agreement,” “CRADA” or “Agreement”** means this Agreement, entered into by NIST pursuant to 15 U.S.C. section 3710a.
- 2.5 **“CRADA Data”** means all recorded information first produced in the performance of this Agreement excluding Proprietary Information.
- 2.6 **“CRADA Invention”** means any Invention conceived in the performance of this Agreement. Research continuing after the expiration date of the CRADA is not covered by provisions of this Agreement.
- 2.7 **“Invention”** means any invention or discovery that is or may be patentable or otherwise protected under Title 35 (35 U.S.C.) or any novel variety of plant which is or may be protectable under the Plant Variety Protection Act (7 U.S.C. 2321 et seq.).
- 2.8 **“Party” or “Parties”** means the Member and/or NIST.
- 2.9 **“Principal Investigator” or “PI”** means the person designated respectively by each Party to this CRADA who will be responsible for the scientific and technical conduct of the research.
- 2.10 **“Program”** means the Scope of Work described herein and other aspects of the CRADA in which Member is involved.

- 2.11 **“Project Team”** means all personnel assigned by the Member to conduct the research designated in this Agreement.
- 2.12 **“Proprietary Information”** means confidential scientific, business, or financial information, including data created under this Agreement solely by the Member at the Member’s research facilities which may embody trade secrets provided by the Member to NIST in the course of this CRADA, and developed exclusively at private expense, except if such information:
- 2.12.1 was in NIST’s possession before receipt from the Member; or
  - 2.12.2 is or becomes a matter of public knowledge through no fault of NIST; or
  - 2.12.3 is received by NIST from a third party without a duty of confidentiality; or
  - 2.12.4 is disclosed by the Member to a third party without a duty of confidentiality on the third party;  
or
  - 2.12.5 is independently disclosed by NIST with the Member’s prior written approval; or
  - 2.12.6 is independently developed by NIST without reference to Member’s Proprietary Information.

### ARTICLE 3. COOPERATIVE RESEARCH

- 3.1 **Research Plan and Changes.** The Statement of Work (SoW) of this CRADA, its termination date and its objectives are detailed in Appendix A. The research under this CRADA shall be performed on a reasonable efforts basis. Member certifies the correctness of the information contained in Appendix A.
- 3.2 **Principal Investigators.** NIST shall be the supervising Federal agency, both administratively and scientifically, for this CRADA. The NIST PI is responsible for the scientific and technical conduct of this project on behalf of NIST. The designated Member PI is responsible for the scientific and technical conduct of this project on behalf of the Member. The Member shall designate the Project Team in Appendix A of this Agreement.
- 3.3 **Project Team.** While at NIST the Project Team shall pursue its activities according to the work schedule and under the Government security and conduct regulations that apply to NIST employees. The project team shall conform to the *Standards of Ethical Conduct for Employees of the Executive Branch* (Executive Order 12674 and 5 C.F.R. Part 2635), hereby made part of this Agreement, to the extent that these standards prohibit private business activities or interests incompatible with the best interest of the Department of Commerce. Individuals selected to work at the other Party’s laboratory will be subject to the acceptance by that Party. Such acceptance shall not be unreasonably withheld.
- 3.4 **Project Team Members.** The Member is encouraged to appoint a Project Team member or members for the Program described herein. The provisions applying to Project Team Members as this term is used in this Agreement shall also apply to members of their supporting staff while serving at NIST as employees of the Consortium Member.
- 3.4.1 **Reimbursement of Project Team Members.** Reimbursement of its Project Team member(s) for travel and related expenditures shall be provided directly by the Member. The Member shall also remain responsible for the Project Team Member’s salary. The Member shall also reimburse NIST for the cost of any special supplies, special material, computation, technical assistance, and/or other special services not contemplated in the SoW and provided to the Project Team Member(s) by NIST in connection with the Program covered by this Agreement. Such

charges shall not be incurred during the period covered by this Agreement without prior approval of the Member.

- 3.4.2 **NIST Approval.** While it shall be the privilege and responsibility of the Member to select its Project Team, they shall also be acceptable to NIST. Such acceptance shall not be unreasonably withheld.
- 3.5 **Change in Member Status.** Member agrees to notify NIST within thirty days should it become subject to the control of a foreign company or government at any time during this Agreement, or if any other change occurs relevant to Appendix A.

#### Article 4. CONSORTIUM MEMBERSHIP

- 4.1 **Membership Limitation.** Membership is limited to 40 for-profit institutions and 15 not-for-profit institutions.
- 4.2 **For-Profit Membership Fees.**
- 4.2.1 **Existing Members:** For existing Consortium Members that are for-profit organizations, the membership fee is twenty thousand US Dollars (US\$20,000) for September 2013 -September 2014 and twenty-five thousand US Dollars (US\$25,000) for each subsequent year. Membership fees must be made payable to NIST, and are due on or before September 30, 2014 and on or before November 30th of each subsequent year.
- 4.2.2 **New Members:** The membership fee will be ten thousand US Dollars (US\$ 10,000) for Consortium Members that are for-profit organizations and that are joining between June 1, 2014 and September 30, 2014. The membership fee will be twenty-five thousand US Dollars (US\$ 25,000) for Consortium Members that are for-profit organizations and that are joining after September 30, 2014. Membership fee for Consortium Members joining between June 1st and November 30th of a year will be reduced by half for that year. Membership fees must be made payable to NIST, and are due at the time of execution of CRADA and by November 30th of each year thereafter.
- 4.4 **Not-For-Profit Membership Fees.** In lieu of membership fees, Consortium Members that are non-profit organizations will contribute personal expertise and materials that are mutually acceptable to NIST and that non-profit Consortium Member.

#### Article 5. PROGRAM DETAILS

- 5.1 **Management.** NIST shall be the supervising agency, both administrative and scientific, for this Consortium. Dr. Ronald Jones shall serve as the NIST PI and Consortium Manager.
- 5.2 **NIST Contribution.** The contribution of NIST shall be in the form of labor, material, equipment, and facilities only.
- 5.3 **Special Equipment.** Special equipment and instruments obtained by the Member from sources external to NIST and provided by the Member to NIST for use in connection with the Program covered by this Agreement will be returned to the Member at the Member's expense and risk as soon as practicable after termination of this Agreement. The Member agrees to assume full responsibility for maintenance of such equipment and instruments and agrees to hold NIST free from liability for any loss thereof or damage thereto unless due to loss or negligence of NIST employees under Section 11.2.1.

## Article 6. TREATMENT OF PROPRIETARY INFORMATION

- 6.1 **Protection.** It is the Parties' intent that no Proprietary Information be disclosed under this Agreement. In the unforeseen event that it becomes necessary to do so, each Party agrees to limit its disclosure of Proprietary Information to the other to the amount necessary to carry out the SoW of this CRADA. The Member shall place a Proprietary Information notice on all information it delivers to NIST under this Agreement, which the Member asserts is proprietary. NIST agrees that Proprietary Information shall be used only for the purposes described in the attached SoW. Except where NIST is legally obligated to release information pursuant to the Freedom of Information Act (5 U.S.C. 552), or other requirement of law, Proprietary Information shall not be disclosed or otherwise made available in any form to any other person, firm, corporation, partnership, association or other entity without the written consent of the Member. NIST agrees to use its best efforts to maintain the confidentiality of Proprietary Information. NIST will promptly notify the Member of requests for Member's Proprietary Information. The Member agrees that NIST is not liable for the disclosure of information designated as Proprietary which, after notice to and consultation with the Member, NIST determines may not lawfully be withheld or which a court of competent jurisdiction requires disclosed.
- 6.2 NIST's obligations are consistent with and do not supersede, conflict with, or otherwise alter the employee obligations, rights, or liabilities created by existing statute or Executive order relating to (1) classified information, (2) communications to Congress, (3) the reporting to an Inspector General of a violation of any law, rule, or regulation, or mismanagement, a gross waste of funds, an abuse of authority, or a substantial and specific danger to public health or safety, or (4) any other whistleblower protection. The definitions, requirements, obligations, rights, sanctions, and liabilities created by controlling Executive orders and statutory provisions are incorporated into this CRADA and are controlling..

## Article 7. INTELLECTUAL PROPERTY

- 7.1 Completion of the Statement of Work as described in Section 12 of Appendix A of this CRADA is not expected to result in any invention.
- 7.2 **Rights to Background Inventions.** No rights to Background Inventions are conveyed by this Agreement.
- 7.3 **Reporting Inventions.** Each Member shall promptly report in writing to the other Members each CRADA Invention disclosed to it. The Member shall ensure that all Project Team members (a) promptly report any CRADA Inventions they make to the Member.
- 7.4 **Treatment of CRADA Data.**
- 7.4.1 **Ownership of Original Copies of CRADA Data.** NIST and the Member agree to exchange all CRADA Data. Subject to these sharing requirements, the creating Party will retain the original copy of all CRADA Data created solely by it. NIST shall retain the original copy of all jointly created CRADA Data; NIST shall supply Member with a copy of the original copy of jointly created CRADA Data, and Member shall have access to the original copy. NIST and Member shall each have the right to use all CRADA Data for their own purposes, consistent with their obligations under this Agreement.
- 7.4.2 **Ownership of Copyrights of CRADA Data.** All CRADA Data produced under this CRADA shall be placed in the public domain, to be freely used by any interested person or entity.

- 7.5 **Publication and Disclaimer.** Except as provided in Sections 7.3, the Parties are encouraged to make publicly available the results of their research. Before either Party submits a paper or abstract for publication or otherwise intends to publicly disclose information about a CRADA Invention, CRADA Data, or Research Products, the other Party shall be provided thirty (30) days to review the proposed publication or disclosure. NIST reports and publications developed under this Agreement shall carry the following disclaimer:

“This work was performed under a Cooperative Research and Development Agreement (CRADA) between NIST and Member. Under the terms of the CRADA, this document may not be used as advertising for any product or service, nor may Member imply to anyone that the CRADA or the research results are an endorsement by NIST of any Member products or services.”

7.6 **CRADA Inventions.**

- 7.6.1 **CRADA Invention.** The Parties do not expect to create any CRADA Inventions during the course of this CRADA. However, should a CRADA Invention be made, all such CRADA Inventions shall be placed in the public domain, to be freely used by any interested person or entity. Nevertheless, each Party shall promptly report in writing to the other Party each CRADA Invention disclosed to it. The Member shall ensure that all Project Team members promptly report any CRADA Inventions they make to the Member.
- 7.6.2 **Declined Option for an Exclusive License.** Member hereby acknowledges that NIST, pursuant to the requirements of 15 U.S.C. section 3710a(b), has offered Member the option to obtain an option for an exclusive license to NIST’s ownership in CRADA Inventions, and that such offer has been declined.

#### ARTICLE 8. TERMINATION

- 8.1 **Termination.** The Member and NIST each have the right to terminate this Agreement, upon thirty (30) days notice in writing to the other party.
- 8.2 **Termination After Change of Control.** NIST may terminate this Agreement immediately if direct or indirect control of the Member is transferred to a foreign company or government; or, if Member is already controlled by a foreign company or government, if that control is transferred to another foreign company or government.

#### ARTICLE 9. DISPUTES

- 9.1 **Settlement.** Any dispute arising under this CRADA shall be resolved amicably between the disputing Members or Parties. As the final resolution of any dispute, a Member involved in the dispute may terminate its Consortium CRADA.

#### ARTICLE 10. NATIONAL COOPERATIVE RESEARCH ACT

- 10.1 **National Cooperative Research Act Filing.** Any Consortium Member may, if it wishes, make a filing under and in accordance with the National Cooperative Research Act that describes the work performed under this Agreement.

#### ARTICLE 11. LIABILITY

- 11.1 **Property.** The U.S. Government shall not be responsible for damage to any property of the Member provided to NIST or acquired by NIST pursuant to this Agreement except as provided in 11.2.1 below.

11.2 **Indemnification.**

11.2.1 **Conduct of Employees.** A Member's Project Team assigned to this SoW are not employees of NIST. The Member shall indemnify and hold harmless the U.S. Government for any loss, claim, damage, or liability of any kind to the Member's Project Team arising in connection with this Agreement, except to the extent that such loss, claim damage or liability arises from the negligence of NIST or its employees. NIST's responsibility for the payment of claims for the loss of property, personal injury or death, or otherwise arising out of any negligent act or omission of its employees in connection with the performance of work under this Agreement shall be governed by the Federal Tort Claims Act.

11.2.2 **Member's Use of NIST Research.** The Member shall indemnify and hold harmless the U.S. Government for any loss, claim, damage, or liability of any kind arising out of the use by the Member, or any Party acting on its behalf or under its authorization, of NIST's research and technical developments or out of any use, sale or other disposition by the Member or others acting on its behalf or with its authorization, of products made by the use of NIST's technical developments.

11.3 **Force Majeure.** Neither Party shall be liable for any unforeseeable event beyond its reasonable control not caused by the fault or negligence of such Party, which causes such Party to be unable to perform its obligations under this Agreement (and which it has been unable to overcome by the exercise of due diligence), including, but not limited to, flood, drought, earthquake, storm, fire, pestilence, lightning and other natural catastrophes, epidemic, war, riot, civic disturbance or disobedience, strikes, labor dispute, or failure, threat of failure, or sabotage of the NIST facilities, or any order or injunction made by a court or public agency. In the event of the occurrence of such a force majeure event, the Party unable to perform shall promptly notify the other Party. It shall further use its best efforts to resume performance as quickly as possible and shall suspend performance only for such period of time as is necessary as a result of the force majeure event.

11.4 **NO WARRANTY.** THE PARTIES MAKE NO EXPRESS OR IMPLIED WARRANTY AS TO ANY MATTER WHATSOEVER, INCLUDING THE CONDITIONS OF THE RESEARCH OR ANY INVENTION OR PRODUCT, WHETHER TANGIBLE OR INTANGIBLE, MADE OR DEVELOPED UNDER THIS AGREEMENT, OR THE OWNERSHIP, NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OF THE RESEARCH OR ANY INVENTION OR PRODUCT.

Article 12. **MISCELLANEOUS**

12.1 **No Benefits.** No member of, or delegate to the United States Congress, or resident commissioner, shall be admitted to any share or part of this Agreement, nor to any benefit that may arise therefrom; but this provision shall not be construed to extend to this Agreement if made with a corporation for its general benefit.

12.2 **Governing Law.** The construction validity, performance and effect of this Agreement for all purposes shall be governed by the laws of the United States.

12.3 **Entire Agreement.** This Agreement constitutes the entire agreement between the Parties concerning the subject matter hereof and supersedes any prior understanding or written or oral agreement relative to said matter.

12.4 **Headings.** Titles and headings of the Sections and Subsections of this Agreement are for the convenience of references only and do not form a part of this Agreement and shall in no way affect the interpretation thereof.

- 12.5 **Amendments.** If either Party desires a modification in this Agreement, the Parties shall, upon reasonable notice of the proposed modification by the Party desiring the change, confer in good faith to determine the desirability of such modification. Such modification shall not be effective until a written amendment is signed by all the Parties hereto by their representatives duly authorized to execute such amendment.
- 12.6 **Assignment.** Neither this Agreement nor any rights or obligations of any Party hereunder shall be assigned or otherwise transferred by either Party without the prior written consent of the other Party except that the Member may assign this Agreement to the successors or assignees of a substantial portion of the Member's business interest to which this Agreement directly pertains.
- 12.7 **Notices.** All notices pertaining to or required by this Agreement shall be in writing and shall be directed to the signatories.
- 12.8 **Independent Contractors.** The relationship of the Parties to this Agreement is that of independent contractors and not as agents of each other or as joint venturers or partners. Each Party shall maintain sole and exclusive control over its personnel and operations.
- 12.9 **The Use of Name or Endorsements.** Member shall not use the name of NIST or the Department of Commerce on any advertisement, product or service which is directly or indirectly related to either this Agreement or any patent license or assignment agreement which implements this Agreement. By entering into this Agreement NIST does not directly or indirectly endorse any product or service provided, or to be provided, by the Member its successors, assignees, or licensees. The Member shall not in any way imply that this Agreement is an endorsement of any such product or service.
- 12.10 **Duration of the Agreement.** It is mutually recognized that the duration of this project cannot be rigidly defined in advance, and that the contemplated time periods for various phases of the SoW are only good faith guidelines subject to adjustment by mutual agreement to fit circumstances as the SoW proceeds. In no case will the term of this CRADA extend beyond the term indicated in the SoW unless it is revised in accordance with Section 12.5.
- 12.11 **Full Execution.** The Member acknowledges that this CRADA is not an offer to enter into a contract and cannot unilaterally be made binding. No contract exists until this CRADA is fully executed and signed by all parties, including the Member, NIST Counsel, NIST Laboratory Director and Chief, Technology Partnerships Office.
- 12.12 **Survivability.** The provisions of Articles 6, 7, 11, and 12.9 shall survive the termination of this CRADA.
- 12.13 **GOVERNMENT DISCLOSURE.** Nothing in this Agreement bars disclosures to Congress or to an authorized official of an executive agency or the Department of Justice that are essential to reporting a substantial violation of law.
- 12.14 **Export of Technical data.** The Member agrees to comply with United States export laws and regulations, including but not limited to the International Traffic in Arms Regulations (22 C.F.R. Part 121 et seq.) and the Department of Commerce Export Administration Regulations (15 C.F.R. Part 730 et seq.). The Member agrees that during the performance of work under this agreement, no technical data created under this agreement which is controlled by United States export laws and regulations shall be disclosed to any foreign national, firm, or country, including foreign nationals employed by the Member, without the Member first obtaining the appropriate licenses or approvals, if necessary.

*[Signatures appear on following page.]*



**Appendix A**  
**The Research Plan/Statement of Work**

**NIST requires the information listed below. NIST considers items 8,10 and 12 proprietary business information.**

1. **Program Project Title.** Development and Validation of Neutron-based Characterization Methods for Morphology and Topology of Soft Materials
2. **Member Eligibility.** In order to assure compliance with section 2 of the Federal Technology Transfer Act of 1986 (15 U.S.C. 3710a), the Member must provide the following information to NIST:

**PLEASE CHECK THE APPROPRIATE BOXES**

- Member certifies that it is not subject to the control of any foreign company or government, and agrees to notify NIST within thirty days should it become subject to the control of a foreign company or government at any time during this Agreement, or any other change relevant to the responses in Appendix A; or
- Member acknowledges that it is subject to the control of the following foreign company or government (if a company, please specify nationality):

\_\_\_\_\_  
Company Name, Country/Government

- Member certifies that it is incorporated under the laws of one of the states or territories of the United States.
  - Member certifies that it has a manufacturing presence in United States.
3. **Protection of Human Subjects.** To assure compliance with 15 CFR Part 27 (the Common Rule for Protection of Human Subjects) and other relevant statutes, regulations and Presidential statements of Policy, the Member certifies that:

- The research to be conducted under this agreement does not involve human subjects within the meaning of 15 CFR Part 27.
- The research to be conducted under this agreement involves human subjects within the meaning of 15 CFR Part 27, and Member agrees to take all steps required by NIST to assure compliance with 15 CFR Part 27. Member certifies that research involving human subjects shall not begin until an appropriate exemption or IRB review is completed and approved by NIST.

4. **Protection of Animal Subjects.** To assure compliance with the Animal Welfare Act as amended and implementing regulations (7 USC 2131 et seq., 9 CFR Parts 1, 2, and 3), and other Federal statutes and regulations relating to animals, the Member certifies that:

- The research to be conducted under this agreement does not involve animal subjects within the meaning of 7 U.S.C. 2131 et seq. And 9 CFR Parts 1, 2, and 3.
- The research to be conducted under this agreement involves animal subjects within the meaning of 7 U.S.C. 2131 et seq. And 9 C.F.R. Parts 1, 2, and 3, and Member agrees to take all steps required by NIST to assure compliance with 9 C.F.R. Parts 1, 2, and 3. Member

certifies that research involving animal subjects shall not begin until documentation of the appropriate reviews and certifications have been provided to and approved by NIST.

5. **Participation in other Federally Funded Projects.** NIST may enter into CRADAs with recipients of awards from other Federal agencies, or other awards from NIST. Member certifies that:

Member's participation in this CRADA is not supported by other Federal or NIST Funds.

Member is a recipient of other Federal or NIST Funding that is related to the work done under this CRADA, and which is identified as: \_\_\_\_\_.

6. **Restricted Information:** Member certifies that:

The Statement of Work (SOW) does not pertain to federally classified or otherwise restricted subject matter.

The Statement of Work (SOW) does pertain to federally classified or otherwise restricted subject matter.

7. **NIST's Principal Investigator:** (The NIST P.I. may change at NIST management's sole discretion.)

Ron Jones  
NIST Polymers Division  
Building 224, Room B314  
100 Bureau Drive, MS 8541  
Gaithersburg, MD 20899-8541  
(301) 975-4624 [ronald.jones@nist.gov](mailto:ronald.jones@nist.gov)

8. **Member's Principal Investigator(s)** (please provide name, mail address, and telephone number):

9. **Duration of the CRADA:** The CRADA shall be effective as of the date of last signature and shall terminate on November 30, 2019.

10. **Member Project Team (name & email or phone), Services, Facilities, Intellectual Property, Equipment, and/or Funds Contributions are Listed as Follows:**

Member Project Team: \_\_\_\_\_

Financial Contributions: \$10,000 due upon execution of the CRADA. \$25,000 annually thereafter.

Specify if invoices will be:  Mail only  Email only  Mail & Email

Billing Contact Name/Payables Department: \_\_\_\_\_ Phone Number: \_\_\_\_\_

Mailing Address for Invoices (if applicable):

Email Address for Invoices (if applicable):

Special Instructions or description to be included on invoice:

**11. NIST Personnel, Services, Facilities, Intellectual Property, and/or Equipment Contributions:**  
(NIST management reserves the right to replace these staff members at its sole discretion.)

NIST Personnel:

Amanda McDermott (MML), (301) 975-4769, [amanda.mcdermott@nist.gov](mailto:amanda.mcdermott@nist.gov)

Kathleen Weigandt (NCNR), (301) 975-8396, [kathleen.weigandt@nist.gov](mailto:kathleen.weigandt@nist.gov)

Kirt Page (MML), (301) 975-5030, [kirt.page@nist.gov](mailto:kirt.page@nist.gov)

PI, per item 7.

NIST Contributions: Equipment and facilities as described for the development of the measurement system.

**12. The Technical Statement of Work (SoW):**

**Objective:** Develop the neutron methodology and technology transfer mechanisms for measurements of soft materials that will positively impact manufacturers of soft materials.

**Responsibilities of Parties:**

NIST:

- Purchase and make use of equipment for the development of the measurement system. All such equipment will be retained by NIST after completion of the project. Data analysis software, measurement protocols and procedures developed at NIST will be made available to the consortium members. A list of equipment and specifications for the measurement system will be provided, so that consortium members can duplicate the system in house.
- Purchase expendable supplies.
- Provide training in measurement techniques associated with consortium activities in the form of presentations at the annual meeting and on-site training in neutron measurements at the NIST Center for Neutron Research.

Member:

- Work with NIST and the consortium members to identify areas of impact in manufacturing best addressed through developments and transfer of technology in neutron based measurements.
- Participate in training in neutron methodology including the annual meeting and on-site measurements with consortium members.

**Technical Objectives:** The technical objectives of the consortium are divided into three tasks detailed below, namely to evaluate, develop, and transfer to consortium members procedures that provide measures of (1) material morphology and topology using neutrons that impact the development of a new generation of materials for manufacturing; (2) measures of morphology and structure under conditions that mimic

manufacturing conditions, including high strain and extensional flow; (3) measures of soft material interfaces including structure and dynamics of interfaces during application of shear.

**Task 1: Evaluate, develop, and transfer to consortium members neutron-based measures of soft material morphology and topology.**

NIST with feedback and guidance from consortium members will develop measures of macromolecular shape, size, and miscibility in filled polymer and polymer blends, protein and polymer based solutions, and colloidal fluids. Specific targets of this task are (1) advancing the measurement and reliability of neutron measurements of molecular topology and interactions in engineering polymer melts, solutions, and high concentration protein solutions; (2) the development of tools capable of probing the location, concentration, and local dynamics of small molecular additives within semi-crystalline polymer films and polymer-based composites; and (3) the development of measures of water ingress into polymeric and porous materials based on neutron imaging and neutron reflectivity. The primary route to solving these issues is the development of fractal data analysis methods and small angle scattering measurement protocols, similar to those seen in studies by Beaucage et al. (J. POLYM. SCI. PART B: POLYM. PHYS.: VOL. 44 (2006)) to characterize quantities such as molecular shape, branching, aggregation, and the distribution of water across porous materials. Finally, we intend to develop routes such as in-situ vapor Small Angle Neutron Scattering (iv-SANS) to highlight the internal structure of relevant materials for manufacturing.

**Task 2: Evaluate, develop, and transfer to consortium members neutron-based measures that probe the structure and dynamics of soft materials under conditions that mimic manufacturing processes.**

The development of structural measurements in Task 1 will be complemented with sample environments that capture important aspects of flow experienced in common manufacturing processes. Specific targets of this task are sample environments that provide high strain and elongational flow studies of soft materials. These include the design, construction, and validation of cells for extensional rheometry of fluids. Potential examples of this technology are the cross slot flow cell and a hyperbolic inlet cell. Other efforts will focus on extensional rheometry of solid polymer films. This could be achieved, for example, with the construction of a Sentenmant Extensional Rheometer for neutron scattering. Also to be developed are environments to examine complex fluids under high strain rates that provide shear rates in excess of  $1.0 \times 10^5 \text{ s}^{-1}$ .

**Task 3: Evaluate, develop, and transfer to consortium members neutron-based measures that characterize the structure and stability of soft material interfaces.**

In addition to the structural characterization of bulk materials and solutions in task 1, this task will develop measures of structure at the soft materials interface. Specific targets of this task are to (1) develop measures of competitive adsorption of multiple component complex fluids at the liquid/air interface, using techniques such as neutron reflectometry on a Langmuir-Blodgett trough or scattering from adsorbed layers of proteins at the glass and metal interfaces; (2) structure, dynamics, and stability of polymers near filler and flat interfaces using techniques such as in-situ vapor Small Angle Neutron Scattering during shear and reflectometry of layers within a shear flow; (3) structure at liquid/liquid interfaces using techniques such as immersion Langmuir-Blodgett scattering.

**Milestones:**

Year 1 (September 2012 – September 2013):

1. Develop in situ vapor capability for Small Angle Neutron Scattering (SANS) and ultra-small angle neutron scattering (USANS). NIST will provide to consortium members a series of data that demonstrates the characterization of the structure of semicrystalline polymer films including polyethylene, polypropylene. Also provide data to evaluate the capacity of this apparatus to measure structure in non-crystalline crosslinked polymer films including polyamide membranes.
2. Evaluate polarized Small Angle Neutron Scattering as a route to increase the reliability and data content of fractal analysis on branched macromolecular systems and aggregated particle fluids. Preliminary data will be taken to compare measurements of a branched polymer bulk sample comparing polarized and unpolarized measurement data.
3. Measurements of interactions of model proteins in solution with an industrially relevant surfactant, including preliminary neutron scattering data, delivered to members. Preliminary data on protein adsorption to a silicon oxide surface also provided, with development of a cell for neutron reflectivity measurements on the adsorbed layer under dynamic fluid flow.
4. Design and modeling of hyperbolic inlet flow cell, or similar cell capable of generating extensional flows in complex fluids, for use in Small Angle Neutron Scattering. Preliminary modeling data provided on the location, size, and reproducibility of a region of elongational flow and necessary parameters from neutron beam optics.
5. Evaluation and characterization of humidity and liquid cell for neutron imaging of flow into porous matrices. Preliminary data will be provided on water ingress into a crosslinked polymer film and a packed column of granular materials.
6. Design and prototype development of cells capable of examining the structure of surfactant layers at an oil/water interface. Characterization data of a surfactant layer adsorbed at a liquid interface provided to members.
7. Evaluation of neutron methods to probe the structure and dynamics of macromolecules at filler interfaces. A report provided to consortium members will detail findings and map suggested areas of emphasis for method development.

Year 2 (September 2013 - September 2014):

1. Development of Sentenmant Extensional Rheometer attachment to be installed on Rheo-SANS apparatus. Preliminary data on Radius of Gyration in solid polymer film as a function of Hencky Strain.
2. Validation of methods to quantitatively track moisture and fluid water ingress into polymer films and granular materials. Data provided to consortium members on the reproducibility and limitations of neutron imaging and scattering for this application.
3. Construction and experimental testing of elongational and high strain rate flow cells for use in Small Angle Neutron Scattering. Test data from a colloidal fluid, isotopically labeled polymer melt, and a protein solution provided to members.

4. Evaluation of neutron methods to probe the structure and dynamics of soft materials at a fluid/fluid interface. A report provided to consortium members will detail findings and map suggested areas of emphasis for method development.
5. Structure, permeation rate, and orientation factor from uniaxially strained semicrystalline polymer films measured in the in situ vapor apparatus provided to consortium members.
6. Report to members details of protein/surfactant measurement protocol, including bulk solution characterization with interfacial adsorption protocols. Data from a model protein-surfactant system provided.
7. High strain rate cell for complex fluids designed and tested, preliminary data from a concentrated protein solution, a polymer solution, and a colloidal fluid delivered to consortium members with measurement protocol and known limitations of the measurement.

Year 3 (September 2014 - November 2015):

NIST and the Consortium Members will perform the following studies together:

1. Develop in situ vapor capability for Small Angle Neutron Scattering (SANS) and ultra-small angle neutron scattering (USANS), and present to consortium members a series of data that demonstrates the characterization of the structure of semicrystalline polymer films including polyethylene, polypropylene. NIST will work with members to develop relationships between data from vapor flow cell data and mechanical properties such as toughness and ultimate fracture strength.
2. Design and build a high pressure cell capable of simulating conditions in geothermal environments, and present qualifying data from cell using small angle neutron scattering measurements to the members.
3. Design and build a more user friendly environment for applying small angle neutron scattering measurements to protein solutions during freeze/thaw and freeze drying operations, and present to the members qualifying data from cell on model antibody solutions.
4. Establish levels of accuracy and uncertainty related to a cross slot flow cell during measurements using small angle neutron scattering, and present data from a model surfactant laden fluid to members.
5. Evaluate and characterize humidity and liquid cell for neutron imaging of flow into porous matrices. Preliminary data will be developed on water ingress into a crosslinked polymer film and a packed column of granular materials.

Year 4 (November 2015 – November 2016):

NIST and the Consortium Members will perform the following studies together:

1. Discuss details of protein/surfactant measurement protocol, including bulk solution characterization with interfacial adsorption protocols. Data from a model protein-surfactant system will be presented to the members.

2. Validate methods to quantitatively track moisture and fluid water ingress into polymer films and granular materials. Data provided to consortium members on the reproducibility and limitations of neutron imaging and scattering for this application.
3. Evaluate neutron imaging methods and cells to probe the infusion of fluids into member-provided geothermal samples at geothermal conditions, including high pressures.
4. Design microfluidic cell capable of  $1 \times 10^5$  s<sup>-1</sup> strain rates in model dilute polymer solutions.
5. Measure depth dependence of water into ultrathin polyamide films using neutron reflectivity. Data will be presented to the members.

Year 5-6 (November 2016 – November 2018):

NIST and the Consortium Members will perform the following studies together:

1. Discuss with members on designs and capabilities for microfluidic device capable of high strain rate measurements on complex fluid systems, including polymer solutions and polymer melts.
2. NIST will present to members the designs for parallel plate rheometry cell for SANS capable of probing structure-property relationships in polymer melts.
3. Design and build porous media column for small angle neutron scattering (SANS), very small angle neutron scattering (VSANS), ultra small angle neutron scattering (USANS), and neutron imaging to advance measurements of fluid phase behavior in high pressure porous media.

Year 7 (November 2018- November 2019):

NIST and the Consortium Members will perform the following studies together:

1. Deliver microfluidic cell capable of  $1 \times 10^5$  s<sup>-1</sup> strain rates in model dilute polymer solutions, deliver test results to members from a micellar solution in water.
2. Design and implement parallel plate shear cell for the application of neutron scattering to polymer melts over a temperature range of 25 to 350 degrees Celsius.
3. Identify new mechanisms to probe extreme environments for neutron-based measurements, including designs for neutron scattering and reflectivity under high pressure and high temperature polymer melts, and deliver report to members at annual meeting.