

Response of the Division of Materials Research to the 2023 Committee of Visitors (COV) Recommendations

The Division of Materials Research (DMR) in the Directorate for Mathematical and Physical Sciences (MPS) extends its sincere gratitude and appreciation to the members of the 2023 COV for the considerable time and effort they invested in reviewing the Division and in compiling a thorough and detailed review of the Division's activities. DMR recognizes and gratefully acknowledges the exceptional leadership and organizational skills of Dr. Timothy Bunning and Professor Kathryn Moler, who served as the co-Chairs of the Committee, expertly and efficiently orchestrating the review and completed the report within a highly demanding timeframe.

DMR appreciates the Committee's high praise for the integrity and efficacy of the processes, as well as for the significance of the scientific accomplishments of the Division. Community confidence and approval are points of pride for program officers and staff members alike. The thoughtful Community guidance delivered as suggestions and recommendations in the COV report is highly appreciated. We hereby provide responses, as appropriate, and outline plans of how DMR will take relevant action and convert to the greatest extent possible the COV recommendations into practice. The DMR response to the COV will be updated annually to reflect progress made.

COV Key Recommendations and DMR Responses:

Recommendation 1: Formulate an explicit strategy for the balance of investments. We recommend that a strategy for investment balance in the future for the Division be formulated. A strategic plan for DMR will simultaneously help the Division Director and his team determine future allocations between existing programs while enabling advocacy to be built around future investment areas within NSF and with external stakeholders (OSTP, Congress, DoE, etc.) for growing investment in materials research. An understanding of where the division believes it sits at unique junctures of future transformative research (autonomous laboratories of the future as an example) should be utilized to focus and synergize future growth opportunities. A future looking strategic plan helps balance the day-to-day reactive budget pressures with higher order, proactive aspirational goals for the division.

- a. Strategic planning should include a discussion on the future opportunities and threats for TMRP, infrastructure and facilities, the MRSEC program, and other current division-led activities, to drive macroscopic balancing decisions. The extensive core expertise of the DMR PDs should be an input to this strategic planning process.
- b. As part of this forward-looking activity, DMR (and NSF as a whole) must address the fact that over the last several years there has been historic increases in the cost of living (increased graduate student, postdoctoral, and PI salaries) as well as the cost of scientific equipment and supplies. The rapidly declining purchasing power of the typical grant and the implications to what is and what is not being funded needs to be considered proactively and as a division. Scientific inflation compared to flat funding levels on single-investigator awards is an existential threat to the health of the NSF and therefore the nation's R&D ecosystem. This poses a major risk to the productivity level of work funded by the NSF. It is critical that NSF and DMR be prepared and have mapped out a strategy; will the division (and directorate/NSF) benefit from fewer, larger grants or a constant number of grants that may no longer fund a full graduate student for a full year? Should priority be placed on large centers with the ability to build significant infrastructure or single PI grants that are distributed more broadly and touch statistically a more diverse institution and PI base?

DMR Response:

12/05/23: DMR fully agrees with the recommendation to formulate a strategic plan for the Division. The DMR 2017-2022 Strategic Plan will serve as an excellent starting point for that endeavor. A Divisional retreat planned for the later part of FY2024 will help incorporate the COV's and the Divisional perspectives into an updated DMR 2024-2029 strategic plan, which, in addition, will explicitly address grant size and duration.

Recommendation 2: Commission a workforce study. The workforce produced by DMR activities feeds and cultivates the economic fabric of the country. We recommend that DMR invite other agencies to join in commissioning a study on the Economic Impact of the Materials Science Workforce, recognizing the breadth of materials research across research disciplines, federal agencies, and industry. The new study should not duplicate but might refresh or expand the 2019 National Academy study, "Frontiers of Materials Research". What is timely now, given NSF's mandate to "advance the national health, prosperity, and welfare", is to assess the economic impact of the materials research workforce previously developed by the NSF along with future materials research workforce needs to maintain global leadership in key economic areas. This study should serve as a foundation for further justification for expanded materials science and engineering activities across the S&T ecosystem.

DMR Response:

12/05/23: While the scale and breadth of the associated endeavor are formidable, DMR will seek to enlist relevant agencies for the commissioning of such an important study.

Recommendation 3: Support best practices for data management that are appropriate to open science. The impact of the rapidly evolving research security landscape on the materials research community is unclear given recent shifts in policy. The near- and far-term primary and secondary effects to the basic research community of open data migration, FAIR data best practices, and increasing policies on information protection are currently unknown. Given the division's unique portfolio, DMR should be proactive in the community (along with NSF as a whole) ensuring the right balance of openness and accessibility through participation in expected further community and policy discussions.

DMR Response:

12/05/23: DMR has long been a forerunner in communicating Data Management and Sharing Plan best practices and expectations via written guidance and dedicated outreach engagements. DMR will continue to closely follow NSF-wide developments on its Public Access Policy, with an aim to provide timely updates and guidance to the communities we serve, as well as opportunities for receiving feedback.

Recommendation 4: Strongly articulate the relevance of the Division's portfolio to the entirety of NSF's mandate. Within the context of NSF's mandate to promote the progress of science; to advance the national health, prosperity, and welfare; and to secure the national defense, DMR should be more proactive in messaging their accomplishments related to the 2nd and 3rd mandates more explicitly within DMR, within the directorate, within NSF, and externally. The division sits at a unique juxtaposition of basic vs use-inspired research content and should utilize its pulpit to ensure that their mission and accomplishments are messaged as more than 'do and publish good science' only. Activities could include

seeking science-driven opportunities to conduct open research that is collaborative with mission-focused agencies and/or facilitating interactions of PDs and PIs with mission-focused agencies to understand shared interests (as an existing example - DMREF).

DMR Response:

12/05/23: DMR is actively taking advantage of a recently streamlined process to broaden, both internally as well as externally, the wide dissemination of the important scientific advances that result from its expansive portfolio of supported research. DMR is also actively seeking to expand partnerships with mission-focused agencies, with the DMREF program being an important pole of attraction and exemplar of success in that endeavor.

Recommendation 5: Increase access to shared experimental and computational facilities. Shared facilities can provide on-demand access to transformative research capabilities and thereby greatly increase the pace, the impact, and the number of participants in cutting-edge research. The COV applauds the large DMR investment that is associated with infrastructure through NaFI, MRSEC, and MIPs. The division could take an even stronger leadership role in ensuring these enabling capabilities are understood across the materials community. Repeatedly, we heard on the one hand there were extensive shared networks of shared facilities (to include computational assets) while on the other hand everyone was wishing for more ability to compete for equipment purchases individually. Is it a supply issue? Is it a demand issue? Is it a lack of awareness issue? Under the programs that DMR owns and leverages, the division should demystify experimental and computational facilities that are available to the general user community. We encourage the DMR to pilot programs that ensure that access to national and regional facilities is broadly available and is directed to the highest-impact work. For example, as a pilot, NSF could direct TACC to set aside a certain number of node-hours for DMR or for a key program within DMR, enabling the program officers to award not only dollars but also access to computing capability.

DMR Response:

12/05/2023: DMR appreciates the importance of ensuring wide access to shared experimental and computational facilities and will certainly include this dimension into the considerations towards developing a division-wide strategic plan.

Recommendation 6: Develop a plan for partnering with TIP. DMR should develop a plan on how best to partner and synergize resources with the new TIP directorate given its infancy. This plan should explicitly address the balance of fundamental and use-inspired research, the importance of fundamental research for translation, and the value of human capital development through academic materials research.

DMR Response:

12/05/23: DMR will continue and expand its active dialogue and partnership-building with the TIP Directorate as it is going through its present formative period.

Recommendation 7: Evaluate the factors that affect proposal volume. DMR should conduct a self-study on staffing and practices for panel reviews and the effect of the switch from open solicitation vs fixed deadline for proposal submission. The DMR PDs should track the quality of their unfunded proposals to help with future allocations and to determine if there has been a drop in the number of quality

proposals. Analysis to include determination of a root cause (switch to open call, size of awards, migration to other funding sources etc.) on why the number of proposals seems to have dropped in some areas for the TMRP groups should be conducted.

DMR Response:

12/05/23: After the conclusion of FY24, which will provide additional submission data that are well-separated from the pandemic-related submission disturbances, DMR will conduct a detailed study of the relevant observations.

Recommendation 8: Develop additional staffing capacity to realize the transformative opportunities of interdisciplinary activities across program lines. As science becomes more multi- and interdisciplinary, it is crucial to find a way for different programs and divisions to share the costs of this joint research taking into consideration the additional time requirements it puts on a finite workforce. The workload of managing each PD's core program, already a full-time activity, is exacerbated as additional opportunities (many prescriptive from higher order leadership) continue to present themselves. This is particularly acute for DMR PD's given the uniqueness of its portfolio. DMR should ensure that current policies enable both internal and external opportunities to be managed with similar integrity and rigor. The division needs to make sure additional PD workload and financial gymnastics within the foundation are considered in the day-to-day execution of the DMR mission. The division should seek to minimize the possibility that truly transformative research is not evaluated and/or not funded due to logistical concerns inherent in the historical NSF business model. DMR should consider monitoring and documenting the workload of DMR PDs on collaborative efforts/programs centered in other divisions.

DMR Response:

12/05/2023: In full recognition of the ever-increasing DMR PD workload under constant staffing and broadening engagements, DMR has taken active steps to judiciously decrease workload by developing significant efficiencies in the administrative components of the PD duties without sacrificing quality or rigor, and by judiciously rebalancing and redistributing workload. One such example is the establishment of the open-window submission process across the TMRPs, which redistributed localized sharp spikes of workload across the whole fiscal year. This critically important active monitoring of PD workload and relevant adjustments will continue. Beyond documenting and strongly articulating the need for increased staffing to meet constantly increasing responsibilities, DMR does not have direct control of its FTE allocation and cannot unilaterally increase its staffing levels.

Recommendation 9: Reinvigorate the Federal interagency for Materials Research (FiMaR) community. DMR should take a leadership role reinvigorating the Federal interagency for Materials Research (FiMaR) S&T community, making sure there is adequate communication amongst the various governmental materials science activities to ensure awareness, to enable synergism of efforts, and to perhaps jointly identify cross-organizational efforts. Given the second and third mandate of NSF, "advance the national health, prosperity, and welfare; and secure the national defense", DMR should utilize these exchanges and linkages arising from within to strengthen connections to synergistic and complementary work enabling the mandates.

DMR Response:

12/05/2023: DMR fully agrees about the importance of FiMaR and will take active steps to reinvigorate that interagency forum.

Recommendation 10: Document the lessons learned from this 2023 COV process for the next COV.

Given the four-year time frame and given the personnel turnover typical in that time frame within the division, DMR should document lessons learned re: the 2023 COV process. DMR staff clearly did an incredible amount of work to prepare for this COV. Question 5 of the 'Other Section' in the feedback forms of each program "NSF would appreciate your comments on how to improve the COV review process, format, and report template" has extensive thoughts from this year's COV participants in the individual program responses showing that COV could have benefited from more tutorials about the tasks at hand. DMR should internalize and consolidate these extensive comments from the individual programs into a 'brain book', documenting procedures, expectations, and lessons learned. This documented 'book' would then be available to DMR and the COV leadership in 3.5 years as the next COV is gearing up. The vast majority of the participants at this event were participating for the first time and so few lessons learned were available from participants. Documentation of what did and did not work well will help shape a successful 2027 COV.

DMR Response:

12/05/2023: DMR deeply appreciates the comments and feedback received from all COV members during the onsite COV meeting and in the COV report itself. A document with COV-related best practices and lessons-learned will be compiled and will be made available for the organization of the 2027 COV.

Recommendation 11: Continue to develop best post-pandemic practices for NSF staff and reviewers.

DMR, together with the whole of NSF, should continue to review lessons learned during the pandemic recovery to establish and document best practices in a post-pandemic environment. These activities should be conducted with transparent and extensive communication between staff and all levels of management, and should address the following topics:

- the balance of remote/hybrid/telework for NSF staff in the new era of hybrid work and telecommuting to include discussion on best optimizing in-person space assignments for division personnel
- best practices for ad-hoc reviews vs review panels
- for review panels, lessons learned on best optimizing 'hybrid' review panels
- the highest priorities for modern and appropriate IT that is uniform and easy to use for both virtual and hybrid review panel activities
- given the strength of DMR's support staff and the existing esprit de corps, the division should participate strongly in a leadership role to develop a MPS Training Framework for support staff which documents best practices re teamwork, and career development.

DMR Response:

12/05/2023: DMR, together with the rest of NSF, began a coordinated return to onsite work in late October 2023. Significant telework and schedule flexibilities remain in place for all employees. A centrally coordinated space reallocation has begun, which is intended to match staff office space to work schedules. The programmatic portion of the upcoming FY 2024 DMR Retreat in the later part of 2024 will explicitly address the question of best practices.

Recommendation 12: Improve clarity and consistency on broader impact criteria for proposers and reviewers. Given the breadth of DMR's footprint, DMR should assess whether additional discussion and/or training is needed w/r to the topic of broader impact. Depending on the nature of the program (single PI, MRSEC, DMREF, etc.), what constitutes broader impact is very different. This was a topic of discussion with the larger COV body and several of the programs had specific written comments on the topic in the report. Given it is one of only two merit-based criteria, clear expectations on what constitutes broader impact for BOTH proposers and reviewers is important to the entirety of the community.

DMR Response:

12/05/2023: DMR will continue to feature this topic in dedicated outreach efforts. In addition, DMR will include this topic in the discussions for the development of an updated DMR Strategic Plan, with an aim to create a strategic approach to providing improved clarity and consistency on what constitutes Broader Impact.

Recommendation 13: Consider computation-first proposals in programs beyond CMMT. DMR needs to re-examine the existing policy of CMMT being the TMRP that reviews computation-based proposals (theory development) regardless of technical discipline. Given the explosion of modern-day theory development in almost every technical discipline and the ever-expanding growth of proposals which have an intertwined experimental and computational component (to include method development), DMR should examine the historical roots of the policy and consider whether changes are needed to realize the current potential for computationally intensive research.

DMR Response:

12/05/2023: Due in part to MGI, the role of computation in Materials research is undergoing a transformation. In the context of MGI, reciprocal interactions among experiment, computation, theory, and data can accelerate not only the discovery of new materials, but also their journey to deployment. DMR is committed to supporting the development of this mode of inquiry, as is reflected in the continuing support of DMREF and the development of computational tools through CMMT, CDS&E, and CSSI, which are foundational to DMREF.

The current program practices of DMR are not designed to raise barriers to advancing computation; they are meant to facilitate appropriate merit review. It is within the scope of any TMRP program in DMR to review and fund projects involving computation (as well as data analytics). Most experimental-computational projects need not involve CMMT, apart from reviewer suggestions, if needed. For projects that have a strong focus on theory and computation, co-review and co-funding can be arranged between the TMRP program and CMMT. There is a broad range of examples of awards resulting from this process. Only in the limit that focus is nearly exclusively on theory or computation, a proposal is appropriate for CMMT. Like the other programs in DMR, CMMT can readily access the expertise of other programs.