CIMAT Review 2007; Carmen Huber, Robert Hull

1. Center Progress and Achievements

In general, the Center continues to make strong progress in research, education, knowledge transfer, collaborations, and outreach.

The research productivity remains very high overall, with 71 publications attributed to the Center in the past year, the great majority of which are well-regarded peer reviewed journals. This is an excellent achievement. The Center continues to attract enthusiastic and talented faculty, postdocs, students and undergraduate students into its research programs. The turnover of personnel is at an appropriate level: a few associate investigators have left the program, while a few have joined. Several postdocs have graduated, some to academic positions associated with CIMAT and some taking positions elsewhere, while new postdocs have joined the Center. Graduation of PhD continues at a very productive rate. Many of the areas of research are of very high quality, and there is significant publication in very competitive journals, such as Physical Review Letters. However, there are concerns about some aspects of the research program, as described in the more detailed evaluations of each research line later in this document.

With respect to emerging areas of research, the major effort seems to be increasing emphasis on research that is related to copper, with a view to potentially building a new research line in this area. We have some concerns here. In one instance, we felt that this was causing the research of an existing group to be pulled in a direction that wasn't consistent with its strength. While recognizing that the relationship with the International Copper Association (ICA) is very valuable, we believe that it should not lead to an artificial emphasis on copper-related research that is not consistent with the investigators' strengths and interests.

The educational efforts of the program remain very strong. The graduate student body of CIMAT remains strong and enthusiastic. CIMAT faculty members continue to make major contributions to the Materials Science PhD program, particularly with Prof. Quijada assuming the role of program coordinator. The undergraduate program has grown greatly, with over thirty undergraduates involved with research in the Center. This is an excellent achievement, and represents a very strong commitment to integrating research and education. Postdocs continue to thrive in the CIMAT environment. Overall the students and postdocs of CIMAT are a great asset to the Center.

There has been considerable emphasis on mechanisms for knowledge transfer in the past two years. Several workshops have been held, which have attracted leading researchers from the international community. The publication record is very strong, and there is excellent participation of CIMAT personnel in international conferences. As center students and postdocs graduate, many are moving onto prestigious positions internationally, further enhancing the perception of CIMAT internationally. The number of patents granted is growing, and this represents a significant breakthrough for the Center. The relationship with the ICA gives CIMAT excellent exposure in the international arena. Overall the impact of the Center is very high in terms of its knowledge transfer.

The program is doing very well in terms of its collaborative networks. The facilities associated with the Center, particularly the crystallography laboratory, form a strong national and regional collaborative network. Each of the research lines has a strong network of international collaborations, with strong records of students and postdocs doing research in laboratories in other countries. The set of workshops associated with the Center are very helpful in this regard. Industrial collaborations are also growing, with the flagship effort being that with the ICA.

The Center participates in many outreach activities. Industrial collaborations and workshops have already been mentioned. With respect to outreach to broader groups such as the lay public and high school students and teachers, the major effort is attributed to Prof. Melo. While his work in this area is excellent, it would be good if more CIMAT participants could engage in similar efforts.

1.a Bio Inspired Materials Group (PI: Dr. José Luis Arias)

Much of this group's research is innovative and fascinating, and is clearly regarded as a flagship effort within the center. However, we had some significant concerns about this group's progress. Its publication record remains modest, and there are relatively few undergraduate and graduate students participating in the group. While the work on bio-mineralization continues to explore new avenues, the progress is not reflected in a strong publication record. The work on inorganic / organic hybrids is a strong collaboration with Prof. Quijada's group, and has led to significant patents. It is not clear to us that the work on use of eggshell materials for bone grafting is an optimum direction. This is a field populated by many other groups more established in this area. Additionally, it was not clear what the advantages of eggshell membranes were over other materials. Overall, we believe the work in this group would be strengthened by more quantitative descriptions in many of its activities. We recognize that the size of this group has been relatively limited, and should be greatly strengthened by the recent introduction of a new postdoc and new associate investigators. This is an excellent opportunity to establish a level of productivity consistent with the rest of the Center. If this does not occur, we believe that there should be a major re-evaluation as to whether this effort should continue if the Center continues beyond its current cycle.

1.b Mechanics of Complex Materials (PI: Dr. Francisco Melo)

This effort is carried out by a large (10) group of investigators, both junior and senior, who are individually productive in this area. The effort includes three main directions: mechanical properties of heterogeneous materials, granular matter, and biomaterials and surface growth. Work in the first two areas has resulted in several publications in archival and high impact journals by the individual investigators over the last year. The work on mechanical properties of heterogeneous materials is strengthened by interactions between theoretical and experimental efforts and this is to be commended. The interactions with French researchers are an added benefit to both student and faculty participants in this area. Research on granular materials benefits from substantial expertise of the individual participants and has clear potential to become a core area of internationally recognized excellence, especially if efforts are made towards greater cohesiveness and internal collaborations in this area. Evidence of the potential of collective efforts in this area are the highly regarded international workshops held on this topic

(last one in Vina del Mar in September 2006) and the student exchange program with a center of excellence in this general research topic at the U. of Chicago. The work on biomaterials and surface growth is an emergent area of interest to this group, one with potentially mutually beneficial links to the Bioceramics thrust. Its progress and impact should become apparent over the next couple of years.

1.c Inorganic Materials (PI: Dr. Evgenia Spodine)

This research line is doing much innovative work in the synthesis of new materials, with good collaboration within the group and with other groups in the Center. It is also contributing superbly to the Center's educational mission in training large numbers of undergraduate and graduate students, and has a very productive publication record. However, some aspects of this group research continue to give us concern. One major issue is that raised in the previous (five year) evaluation, where it was stated, "the panel did not feel there was a well articulated research mission for this research line – it was not clear what fundamental questions this research is targeted at". This concern remains: of the various exotic structures synthesized (with extraordinary skill and expertise) in this group the questions remain: why these particular structures and how will they be used? The second major issue is the work on copper related research. This seemed to be a direction that did not match well to the expertise in this group. We found this work to be uncompelling, and significantly below the standard of research elsewhere in this group. It seemed to us to be an example of a counter-productive result of an artificial emphasis on copper related research. The expertise and time of this group could be used better in other research avenues. In summary, we still believe that this group has a strong role to play within the Center and in the future of materials research in Chile, but a clear research vision needs to be articulated, and the research should focus on the areas of greatest impact and expertise.

1.d Catalysis and Polymeric Materials (PI: Dr. Raul Quijada)

This research thrust addresses questions of interest within the broad areas of catalytic and polymeric materials. Within this substantial breadth, the participants have been able to target specific areas where their collective efforts have made a significant impact. This is evidenced by a large number of publications in internationally recognized journals, and patents submitted and granted both in Chile and the US. Important results from recent work by this group on modification of polyolefins have been featured in the cover page of *Macromolecular Chemistry* and Physics. The group is very interactive, both internally and with other thrusts within CIMAT (the Bioceramics and Inorganic Materials thrusts). A large number of undergraduate and graduate students participate in this effort. Furthermore, over half of the undergraduate theses in CIMAT in the last year have developed within this thrust. Overall, the impact of this group on the education and training of students is substantial. The emergent effort on copper-based catalysts for air pollution control is a positive example of how well informed and potentially successful efforts on copper-related research can naturally evolve on the basis of existing expertise and research interests. The participating investigators have a large number of international collaborations, both within the academic and industrial sectors, and have evolved into a resource in this research area for the rest of Latin America.

2. Value added by the Center

Overall, it is clear that CIMAT brings added value to the individual efforts of participants. In the research arena, some thrusts have been quite successful in demonstrating the value added by their collaborations (particularly the Catalysis and Polymeric Materials group), some have been able to tackle problems of scope that require a decade's commitment, and others continue to make progress along these lines through emerging collaborative areas of research. In the education arena, activities such as the revitalization of and continued participation in the PhD in Materials Science program, organization of highly successful international workshops, and the undergraduate research internship program would not have been accomplished without CIMAT. CIMAT not only puts in the necessary financial resources but also, and more importantly, a cohesive intellectual effort. Likewise, in the knowledge transfer arena, it is safe to assume that the successful and growing partnership with the International Copper Association would not have been possible without CIMAT.

3. Management

The management of the structure appears to be very effective. The management team of the PI and four co-PIs (who are also the four research line leaders) appear to work together very well. The Director and co-Director seem to have a particularly strong rapport. The Director, Fernando Lund, has a very strong knowledge of all aspects of Center operation, and represents all areas of the research program very impressively. He clearly has the respect and appreciation of all those involved in the Center, and is to be commended for the excellent job he is doing. From discussion with the Center's Associate Investigators, they generally felt that they were well invested in the Center planning and budgetary processes, and each co-PI has appropriate authority over his/her research line planning and operations. The postdocs and students involved in the Center also appear to be very appreciative of the opportunities afforded to them by involvement with the Center. Administrative functions appear to be performed efficiently.

4. Recruitment

There is evidence of increasing number of participants in CIMAT across the whole spectrum. At the faculty level, CIMAT has demonstrated flexibility in not only involving new hires (in the last year two have already arrived and one is currently being recruited at U. de Chile), but also in incorporating existing faculty at the participating universities as well as other academic institutions such as PUC (4 in the last year). Five postdoctoral associates (4 funded through CIMAT) participate in CIMAT. Three postdocs left over the last year and took faculty positions in Chile and abroad. Thirty-two graduate students participated in CIMAT in the last year, about 40-45 undergraduates, including 32 who are doing undergraduate theses and 15 undergraduate research interns. The number of postdoctoral and of student participants, both at the graduate and undergraduate levels, exceeds expectations. Associate investigators, postdocs and student participants all expressed satisfaction and acknowledge benefits derived from their involvement in CIMAT.

5. Institutional Commitment

The meeting of institutional commitments made at the commencement of FONDAP for faculty hires has been an area of consistent concern in previous reports. In the current evaluation period, however, substantial progress has been made. Two researchers (Andronico Neira and Diego Venegas) who were previously CIMAT postdocs, and who are deeply involved in the CIMAT program, have been hired into the faculty of the University of Chile. A third search, focusing on the crystallography laboratory, is in progress and an offer has been made to a candidate in Europe.

6. Advisory Committee

The external advisory board appears to be quite active, meeting annually, and making substantial suggestions that the CIMAT management appears to be responsive to. The board has very accomplished national and international representatives. It could perhaps be more active in promoting CIMAT internationally, for example by generating invited talks for CIMAT faculty.

7. Other

We regard the Director as being superbly qualified for this position. He is extremely knowledgeable in all aspects of Center operation, directs the Center very effectively, works well with the Center leadership, and has the respect of all Center participants.

As an area for improvement, we believe that the Center fails to do itself justice in reporting and in reviews. In reviews, presentations should be effectively targeted to the time slot. While recognizing that some delay was due to questions by the evaluation committee, several presentations seemed almost a factor of two too long for the time allocation. This lead to some research areas being described too hurriedly, and whole areas of Center achievement (such as in education) being largely omitted, even as the presentations fell dramatically behind schedule. As the Center is considered for continuation at the end of the ten-year period, several such presentations may have to be made by the Center leadership. It is imperative that the presentations be coordinated, practiced in advance, and organized to give the best possible impression of the Center. This was not achieved in the current review.

We recommend that the Center leadership and CONICYT administration meet to develop together the optimum content and format for the annual report. The reports could be substantially improved. Significant areas, such as in graduate student education, were largely omitted, and some research areas failed to give an overall rationale for their work. At the same time the format of the questions posed to the Center are often non-optimal. For example, there have been concerns about institutional commitment in past reviews. This seems to be improving, given several new faculty hires in the last year. However in the reporting section (#4), "Accomplishment of institutional commitments", the director reported nothing (i.e. the section was blank). While we certainly believe that the Director could and should have given a substantive response in this section, the sub-phrasing for the section "Please indicate any difficulties regarding this aspect in the following space" implies that only difficulties are to be

addressed, not achievements. There are several other areas where the format of the report (such as in the appendices) verged on the illegible.

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