GRADUATE STUDENT COUNCIL

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Made@Vanderbilt – a Device Fabrication & Testing Facility

OVERVIEW

Problem

Many graduate students' projects focus on the development of components for real-world devices in the broad categories of energy conversion and storage, sensing, and medicine, including solar cells, water-splitting and fuel cells, lithium ion batteries, air pollution and explosives sensors, light detectors, rapid diagnostic tests for malaria, and drug delivery, among others. However, testing novel materials in such experimental devices is problematic. Learning how to build functioning devices and test them as a novice outside of an engineering specialty can be a difficult undertaking for a graduate student. Often, there is insufficient detail in the literature to directly reproduce results, and many journals require minimum efficiencies or other figures of merit to be met for publication of new research. Therefore, there is a very steep learning curve to device testing which can take precious time away from scientific progress made during completion of a Ph.D., ultimately limiting the attractiveness of these Ph.D. recipients to potential employers. In some cases, a graduate student would have to travel to receive training on device fabrication at a cost to the university, directly or indirectly through grant funds. Also, the focus of a given field can shift abruptly as new breakthroughs are made around the globe, requiring graduate students to learn multiple novel device architectures to remain relevant.

Solution

The proposed solution is to create an interdisciplinary core facility called "Made@Vanderbilt" which specializes in device fabrication and testing, stays up-to-date on best practices, and collaborates with

groups across campus to rapidly test novel materials in optimized devices. This facility will be part of the CORES System at Vanderbilt. Made@Vanderbilt will also train graduate students in modern device testing techniques to make them more attractive to potential employers without delaying their projects. In most cases, the success of a student's project depends on their training – self-taught or otherwise – in device assembly and testing. Whereas with the proposed center, student training and device testing will be separate, at least at the beginning. The center can also train visiting graduate students and scientists for a reasonable fee.

IMPACT

Made@Vanderbilt will decrease time-to-publication and allow research groups at Vanderbilt to stay ahead of the curve in their respective fields. Modern alternative energy device testing and innovation will be highly relevant over at least the next century if not longer, as society transitions from fossil fuel to alternative energy technologies. Thus housing such a center will increase Vanderbilt's impact on society and raise its reputation in the scientific community. There are few related centers in the U.S., such as the UNC Chapel Hill Energy Frontier Research Center (EFRC) funded by the Department of Energy, UNC Charlotte Center for Optoelectronics & Optical Communications, and the University of Washington Clean Energy Institute (see Appendix), but none that offer the scope of device testing and training proposed here. The broad relevance of Made@Vanderbilt will attract a diverse and international demographic of students who desire to improve existing technologies, carrying their skills to research in academia or industry. The interdisciplinary and trans-institutional nature of this center that combines engineering with chemistry, materials science, and medicine will bring research groups across campus together to solve major societal problems. Furthermore, Made@Vanderbilt will work closely with The Wondry to support innovations formulated by undergraduate students. Having a center specifically devoted to state-of-the-art device testing is also a boon to grant applications submitted by Vanderbilt P.I.'s. Finally, accelerating research and putting Vanderbilt on the forefront of energy and medical innovation will increase activity for the Center for Technology Transfer, specifically in disclosure of intellectual property, patent applications, licensing to external corporations, and creation of startup companies.

GOALS

1. Provide Vanderbilt graduate students, P.I.s and other researchers with a rapid, state-of-the-art, device fabrication & testing facility.
2. Train Vanderbilt and visiting scientists in such techniques, attracting outstanding & diverse students to Vanderbilt and enabling them to pursue exceptional career paths.
3. Advance technology and society in the areas of alternative energy, sensing, and medicine.
4. Foster the innovation of intellectual property at Vanderbilt and work with the Center for Technology Transfer & Commercialization to apply for patents and license them to companies.

IMPLEMENTATION

A committee of faculty from Chemistry, the Medical School, Engineering, and Physics as well as a representative from Vanderbilt Institute for Nanoscale Science & Engineering (VINSE) will be formed. This committee will decide allocation of space in the new Science & Engineering building, choose a Scientific Director from the faculty, hire an Operations Manager, and assemble a team of specialists in modern device architectures, fabrication & standard testing techniques. The specialists will advise on the acquisition of top-of-the-line instrumentation required for device testing, e.g. a solar simulator lamp, potentiostats, a 3D printer, etc. Further, the committee will hire research staff and postdoctoral associates to provide research and consulting support.

ESTIMATED COST

Personnel

Core Operations Manager: $80,000/year

Core Scientific Director: $5,000/year

3 Specialists: $70,000/year

3 Research Staff & Postdoctoral Research Associates: $45,000-$65,000/year

Top-of-the-line testing instrumentation: $50,000

Instrument service contracts: $5,000/year

Annual operating and maintenance costs

VINSE Usage: $50,000/year

Consumables (e.g. gas tanks, chemicals, supplies) $16,000/year

Repairs: $10,000/year

Estimated Cost for first year: $561,000.00 - $621,000.00

Estimated Annual Cost for subsequent years: $511,000.00 – $571,000.00

APPENDIX

UNC Chapel Hill EFRC (http://www.efrc.unc.edu/index.html)

1) Administrative Structure
   a) Scientific Leadership composed of UNC Faculty
      i) Director, Deputy Director(s), Team Leaders (e.g., Photocathode, Catalysis)
   b) Advisory Boards
      i) External: composed of Faculty and Research Center Directors from other Institutions
      ii) Internal: composed of representatives from University Administrative Offices (Deans, Vice Chancellors and Provosts) and Chairs of participating science departments
   c) Staff
      i) Administrative: Assistant Director & Executive Assistant
      ii) Research: Senior Research Scientists
2) Impact
   a) 249 publications since 2010
   b) "Inspired by natural photosynthesis and the concept of the artificial leaf, research at the UNC EFRC has led to the concept of the Dye Sensitized Photoelectrosynthesis Cell (DSPEC), an important approach in the field of Artificial Photosynthesis… A solid foundation in understanding the fundamental processes behind the DSPEC has been established in the UNC EFRC." -Atlas of Science (https://atlasofscience.org/fuel-from-sunlight-and-the-new-energy-economy/)

UNC Charlotte Center for Optoelectronics & Optical Communications (http://opticscenter.uncc.edu/)

1) Administrative Structure
   a) Director, Assistant Director (Research Operations Manager)
   b) Participating Faculty (Professors including Chaired, Full, Associate, Assistant, and Adjunct)
   c) Faculty Associates
      i) Research Staff
      ii) Cleanroom Managers
   d) Postdoctoral Research Associates
   e) Staff
      i) Communications & Web Site Manager
      ii) Business Services Coordinator
      iii) IT Support Specialist

University of Washington Clean Energy Institute (http://www.cei.washington.edu/)

1) Administrative Structure
    a) Leadership Team
        i) Chief Scientist
        ii) Director
    b) Advisory Council composed of leaders from businesses and non-profit organizations
    c) Faculty Advisory Board
    d) Member Faculty
    e) Affiliated Faculty
    f) Graduate Fellows
    g) Washington Research Foundation Innovation Postdoctoral Fellows
    h) Staff
        i) Managing Director
        ii) Assistant Director of Operations
        iii) Scientists
        iv) Director of Education
        v) Finances
        vi) Communications
        vii) Events

2) Impact
    a) "CEI has selected six research projects for its 2016-2017 Student Training & Exploration Grants. The institute made roughly $200,000 in awards this year. These grants support student education at the University of Washington by providing scholars the freedom to explore novel, high-risk/high-reward research topics. The projects seed new collaborations in research and education that increase the prospects for future support from federal funding agencies and other large-scale collaborative grants." -CEI News (http://www.cei.washington.edu/2016-2017-student-training-exploration-grants/)