Rec 10/7/16

MTSU Clean Energy Initiative Project Funding Request

There are five (5) sections of the request to complete before submitting. See http://www.mtsu.edu/sga/cleanenergy.shtml for funding guidelines. Save completed form and email to cee@mtsu.edu or mail to MTSU Box 57.

1. General Information	
Name of Person Submitting Request Dr. Keying Ding	
Department/Office Chemistry/SCI 3024	Phone # (Office) 615-898-2475
MTSU Box # 68	Phone # (Cell) 615-956-5990
E-mail Keying.Ding@MTSU.edu	Submittal Date 10/07/2016

2. Project Categories (Select One)			
Select the category that best describes the project.			
	Energy Conservation/Efficiency	X	Sustainable Design
	Alternative Fuels	x	Other
	Renewable Energy		

3. Project Information
a. Please provide a brief descriptive title for the project. **b.** The project cost estimate is the expected cost of the project to be considered by the committee for approval, which may differ from the total project cost in the case of matching funding opportunities. **Any funding request is a 'not-to-exceed' amount. Any proposed expenditure above the requested amount will require a resubmission.** c. List the source of project cost estimates. d. Provide a brief explanation in response to question regarding previous funding.
3a. Project Title **Bring Green Chemistry on Campus (IV)**
3b. Project Cost Estimate $3016.80
3c. Source of Estimate: Sigma-Aldrich
3d. If previous funding from this source was awarded, explain how this request differs? This is a different project aiming to developing an innovative and sustainable

base transition metal iron based catalyst for challenging and important small molecular activations and organic reactions. The results from this project will serve as preliminary data for an NSF grant application in 2017.

Thanks to the previous supports from Clean Energy Fee and others, I have led our faculty team from Chemistry Department to a successful NSF MRI grant to acquire of a Single Crystal X-ray Diffractometer for research, teaching and education. (**MRI:1626549, $299,999**) Moreover, one research paper partially supported by Clean Energy Fee is being submitted for publication. Clean Energy Fee has been formally acknowledged in the paper. Another great news is our **Chemistry Club has won ACS Green Chemistry Student Chapter Award in both years 2015 and 2016**. (I am the faculty advisor) I am thankful for the previous supports on some of the green chemistry outreach/education activities within the MTSU community. I really appreciate that Clean Energy Fee can continue to gratefully support our "**Bring Green Chemistry on Campus**" program.

4. Project Description

(Completed in as much detail as possible.)

a. The scope of the work to be accomplished is a detailed description of project activities.
b. The benefit statement describes the advantages of the project as relates to the selected project category.
c. The location of the project includes the name of the building, department, and/or specific location of where the project will be conducted on campus.
d. List any departments you anticipate to be involved. Were any departments consulted in preparation of this request? Who? A listing may be attached to this form when submitted.
e. Provide specific information on anticipated student involvement or benefit.
f. Provide information for anticipated future operating and/or maintenance requirements occurring as a result of the proposed project.
g. Provide any additional comments or information that may be pertinent to approval of the project funding request.

4a. Scope: Work to be accomplished

The whole proposal describes a research aiming at design, synthesis and characterization of a novel class of earth-abundant metal iron complexes featured with a unique and tunable Fe–H–B interaction for a challenging C-H bond activation of benzene. Frustrated Lewis pairs (FLP) chemistry has recently received much research effort in small molecule activations and organic synthesis. However, current FLP chemistry depends largely on a very strong Lewis acid, $B(C_6F_5)_3$ and its derivatives, which places serious limitations on chemoselectivity, functional group tolerance and catalytic performance. $B(C_6F_5)_3$ is also an expensive reagent. In this project, this challenge will be targeted by a new type of FLP based on iron hydride/borane complexes. In this novel design, a tunable Fe–H–B interaction is proposed to play a key role in replacing $B(C_6F_5)_3$ with a weak Lewis acid, without losing the reactivity. C–H bond activation of benzene by these complexes will be studied to explore the reactivity and provide mechanistic insight. This project will also contribute to the principles of green chemistry by replacing expensive and unsustainable metal complexes with earth-abundant and environmentally friendly iron based ones. The ligands and iron complexes will be synthesized and characterized by standard physical methods such as NMR spectroscopy, UV-vis, IR and single crystal neutron diffraction. Students will be trained with advanced synthetic skills, physical analytical methods and responsible conduct of research. This project will also be integrated with educational/outreach activities in order to disseminate the concepts of green and sustainable chemistry.

Specifically, in this proposed work, we will only focus on synthesis and characterization of this proposed ligand, which will serve as preliminary data for major external grant applications.

I will continue to organize green chemistry activities and events, which will ultimately benefit our MTSU community. Previous education/outreach activities are summarized below.

4b. Scope: Benefit Statement

Since joining MTSU in 2013, I have initiated and established a unique "**Bring Green Chemistry to Campus**" program aiming to disseminate green and sustainable science and technology and educate the next generation of researchers within the MTSU community, throughout collaborative research, teaching and outreach. Previous and current activities have included: (1) Several research projects in green catalysis supported by MTSU Clean Energy Fee Program, which involve undergraduate and graduate participants. The students will have the opportunity of being trained and performing research and becoming skilled scientists in the future; (2) Green chemistry invitational seminars by three well-known US scientists, which are supported by MTSU Distinguished Lecture Fund and Golden Goggle Lectureship. Through these seminars, students have the opportunity to learn what's going on in these cutting-edge research areas and broaden their views; (3) Green chemistry demos and presentations in National ACS meetings, Southeastern ACS regional meetings, Discovery Center at Murfree Spring, and university and local fairs such as Expanding Your Horizons (EYH) (participants are K-12

school girls), new Science Building events (participants are from local elementary schools) and Earth Day posters supported by NSF CHE (open to the MTSU community), etc.; (4) Introduction of a "Green Moments" section in General Chemistry courses (I and II). I incorporate civic engagement in teaching by advocacy of green chemistry concepts and principles. In the General Chemistry classes, I addresses critical sustainability problems such as global warming and ocean acidification, which are closely related to the topics of the lecture. These "Green Moments" use real-world contexts to teach more complicated concepts in General Chemistry; (5) Advocate to replace common plastic wares and cups with renewable and biodegradable PLA based ones at the MTSU Student Union food court. Students and I drafted a letter to the President of MTSU and hope that the University can pay attention. The MTSU Chemistry Club has won 2015 and 2016 ACS Green Chemistry Student Chapter Award. The proposed project will greatly contribute to "Bring Green Chemistry to Campus" program that will ultimately benefit our MTSU community.

4. Project Description (continued)

4c. Location of Project (Building, etc.)

SCI-3021

4d. Participants and Roles

One graduate student (Keshav Paudel) will perform the experiments under the supervision of me. An undergraduate student will assist in the research.

4e. Student participation and/or student benefit

Working on this project, students will not only learn basic concepts of green and sustainable chemistry but also get hands-on research experiences in this field. We hope that through our proposed "Bring Green Chemistry on Campus" program, more MTSU students will get involved and learn green chemistry. Most significantly, through this project, students can learn how green chemistry is so important and promising today and get interested in green chemistry, which will ultimately benefit our MTSU community.

4f. Future Operating and/or Maintenance Requirements

See 4a, 4b

4g. Additional Comments or Information Pertinent to the Proposed Project

Results from this project will serve as preliminary data for major external funding applications.

5. Project Performance Information

Provide information if applicable.

a. Provide information on estimated annual energy savings stated in units such as kW, kWh, Btu, gallons, etc.
b. Provide information on estimated annual energy cost savings in monetary terms.
c. Provide information on any annual operating or other cost savings in monetary terms. Be specific.
d. Provide information about any matching or supplementary funding opportunities that are available. Identify all sources and explain.

5a. Estimated Annual Energy Savings (Estimated in kW, kWh, Btu, etc.)

N/A

5b. Annual Energy COST Savings ($)

N/A

5c. Annual Operating or Other Cost Savings. Specify. ($) N/A
5d.Matching or Supplementary Funding (Identify and Explain) N/A

SIGMA-ALDRICH

Order Preview(This order has not been submitted)

Web Copy

Billing Address MIDDLE TENNESSEE STATE UNIVERSITY Dept:MTSU 1500 GREENLAND DRIVE MURFREESBORO,Tennessee 37128 United States	**Shipping Address** MIDDLE TENNESSEE STATE UNIVERSITY Dept:CHEMISTRY 1500 GREENLAND DRIVE MURFREESBORO,Tennessee 37132 United States
Order Date:2016-10-07 **Purchase Order:** **Additional Reference:** **Payment Term:Prepaid - 1 day net**	**Contact Name:Keying Ding** **Contact Phone:6158982475** **Contact Email:keying.ding@mtsu.edu** **Email order confirmations to:**

Subtotal:2,994.80 USD
Ice/Special Packaging Charges:22.00 USD
Order Total:3,016.80 USD

Line	Product Number	Description	Qty	Your Reference	Your Price	Net Price
000010	692360-1G	SODIUM TETRAKIS(3,5-BIS(TRIFLUOROMETHYL&	1		441.00	441.00
		1 In Stock from MILWAUKEE 10/07/16				
000020	290157-50G	1,3-BIS(TRIFLUOROMETHYL)-5-BROMOBENZENE&	1		141.50	141.50
		1 In Stock from MILWAUKEE 10/07/16				
000030	698172-25G	IRON(II) TRIFLUOROMETHANESULFONATE	1		278.00	278.00
		1 In Stock from MILWAUKEE 10/07/16				
000040	188913-25G-A	CATECHOLBORANE, 98%	1		199.50	199.50
		1 In Stock from MILWAUKEE 10/07/16				
000050	682098-10G	BORANE-AMMONIA COMPLEX, 97%	1		317.00	317.00
		1 In Stock from MILWAUKEE 10/07/16				
000060	179752-25G	BORANE-PYRIDINE COMPLEX	1		80.20	80.20
		1 In Stock from MILWAUKEE 10/07/16				
000070	179043-25G	BORANE-N,N-DIETHYLANILINE COMPLEX	1		87.90	87.90
		1 In Stock from MILWAUKEE 10/07/16				
000080	180203-5G	BORANE-MORPHOLINE COMPLEX, 95%	1		29.90	29.90
		1 In Stock from MILWAUKEE 10/07/16				
000090	442593-1G-A	TRIS(PENTAFLUOROPHENYL)BORANE, 95%	1		153.00	153.00
		1 In Stock from MILWAUKEE 10/07/16				
000100	440574-50ML	ETHYLTRIETHOXYSILANE, 96%	1		65.40	65.40
		1 In Stock from MILWAUKEE 10/07/16				
000110	440108-100ML	TRICHLORO(PHENYL)SILANE, >=97.0%	1		36.10	36.10
		1 In Stock from MILWAUKEE 10/07/16				
000120	440213-100ML	TRIETHOXY(OCTYL)SILANE, >=97.5%	1		43.80	43.80
		1 In Stock from MILWAUKEE 10/07/16				
000130	480568-1G	DIPHENYLSILANE-D2, 97 ATOM % D	1		224.50	224.50
		1 In Stock from MILWAUKEE 10/07/16				
000140	380415-10ML	PHENOXYTRIMETHYLSILANE, 97%	1		53.80	53.80
		1 In Stock from MILWAUKEE 10/07/16				
000150	710369-2G	BIS(2-FURYL)PHOSPHINE CHLORIDE, 85%	1		108.00	108.00
		1 In Stock from MILWAUKEE 10/07/16				
000160	333670-1G	TRIS(TRIMETHYLSILYL)PHOSPHINE, 95%	1		127.00	127.00

		1 In Stock from MILWAUKEE 10/07/16				
000170	395102-1G	TRIS(4-METHOXYPHENYL)PHOSPHINE, 95%	1		35.20	35.20
		1 : Estimated to ship on 10/20/16				
000180	710563-1G	TRIS(O-METHOXYPHENYL)PHOSPHINE, 96%	1		44.20	44.20
		1 In Stock from MILWAUKEE 10/07/16				
000190	383767-1G	TRI-2-FURYLPHOSPHINE, 99%	1		81.10	81.10
		1 In Stock from MILWAUKEE 10/07/16				
000200	710555-1G	DI(O-TOLYL)PHOSPHINE, 97%	1		56.20	56.20
		1 : Estimated to ship on 12/02/16				
000210	686697-5G	CHLORODI(O-TOLYL)PHOSPHINE	1		251.00	251.00
		1 In Stock from MILWAUKEE 10/07/16				
000220	666629-1G	TRIS(4-TRIFLUOROMETHYLPHENYL)PHOSPHINE,	1		140.50	140.50
		1 In Stock from MILWAUKEE 10/07/16				