UNLV | ECONOMIC DEVELOPMENT

UNLV & Community Stakeholders Technology Commercialization Project

Six-Month Progress Report

Reporting Period: March 1, 2022 – August 31, 2022

Report Date: October 3, 2022

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Project Purpose

The UNLV & Community Stakeholder Commercialization Project is focused on the development and successful commercialization of inventions developed by UNLV faculty and staff with a specific goal of increasing both the total number of inventions licensed and the number of business startups established. This effort supports GOED's mission to "conduct research and create intellectual property that will be used to develop new, relevant technologies to help companies grow their R&D base and enhance their growth through innovation." The project established the following initiatives:

1. Standardized community assessment for de-risking technologies
2. Engaging community subject matter experts through Entrepreneur-In-Residence (EIR)/ Executive-In-Residence (XIR) modeled efforts
3. Translational grant funding and commercialization validation

Standardized Community Assessment for De-Risking Technologies

The primary purpose of this initiative is to implement new programs that are organized around and involve qualified community groups, service providers, subject matter experts, serial entrepreneurs, and individuals engaged by UNLV's Office of Economic Development ("OED"), to assist with the identification, assessment and ultimately the successful commercialization of UNLV inventions. In short, the primary function of these groups is to "de-risk" the inventions and provide development and commercialization guidance and mentorship. The success of this initiative will be measured through an increase in technologies licensed and startup companies formed. This initiative is expected to last, at minimum, through later-2022. These community groups and individuals will serve as mentors and resources for both UNLV inventors as well as to startup companies based on UNLV inventions.

The OED is now actively engaging individuals and community groups and other Nevada-based organizations specializing in entrepreneurial and startup support to help with this initiative and serve as part of a "De-Risking Team." One of those engaged groups, Entrepreneurs Assembly (EA), is a Nevada-based organization that has an extensive network of business owners and subject-matter experts on their roster and is now providing support to successfully de-risk and commercialize UNLV inventions. Additional community groups with appropriate expertise and capabilities may be added. EA will assist the OED by engaging with UNLV faculty inventors and Licensing and Business Development team at OED to identify and assess innovations, as may be protected by intellectual property rights, for commercial viability.

De-Risking Goals

This community-based invention de-risking will rely on EA and other various De-Risking Team members, working in conjunction with UNLV and its designees, to identify and advance priority UNLV inventions. The goal for this initiative is to create one startup or spinout business per year, and the completion of two licensing agreements per year, for the two-year trial period, or in lieu of one of these goals, obtain additional funding to further develop inventions to the point they are suitable for spinout or licensing agreements.

By utilizing expertise and experience from EA and OED's Technology Assessment Committee (TAC), OED is proactively engaging with community members to increase the likelihood of successfully commercialized inventions. Additional details regarding TAC and EA follow below.

Technology Assessment Committee (TAC)

The OED Technology Assessment Committee (the "TAC") is comprised of subject-matter experts, entrepreneurs, mentors, venture capitalists, leaders in the business community, and government representatives who assess and champion UNLV based inventions toward commercial success. TAC and OED work in partnership to advance protectable inventions and intellectual property with significant commercial potential through developing and applying start-up, licensing, and business development strategies. This TAC initiative will help unify the economic development sectors through a document-driven assessment and commercialization process.

Members of TAC provide important technical, product development, intellectual property and market information allowing OED and the business community to make more informed, data-driven decisions whether to expend resources protecting and commercializing promising inventions. With the advent of the new Harry Reid Research and Technology Park, TAC will have a greater platform than ever before to engage with forerunners of innovation in key industries within the Las Vegas valley and beyond.

It should be noted that given the demands of COVID-19, in-person TAC meetings remain suspended, and none were held during the current reporting period. Notwithstanding, TAC members continued to assist with de-risking technologies through a less formal engagement using primarily email and Zoom meeting approaches.

Entrepreneurs Assembly (EA)

Entrepreneurs Assembly (EA), a Nevada non-profit organization, serves as a global community for the entrepreneur. EA is dedicated to mentoring and advising entrepreneurs in creating and growing their businesses. By creating local collaborative communities of entrepreneurs and mentors, they continue to promote economies around the world. Over the last 9 years, EA has mentored and advised over 1,000 entrepreneurs, startups and small businesses – with the belief that entrepreneurial small businesses are the future of the global economy.

Entrepreneur-In-Residence (EIR) / Executive-In-Residence (XIR)

An EIR/XIR is a proven business expert that serves as a mentor and guide to members of the UNLV community. EIRs/XIRs are intended to provide insightful and actionable guidance and mentoring to increase the likelihood of success of UNLV inventions and startup ventures, while also fostering engagement between UNLV and the local entrepreneurial community to accelerate the commercialization of UNLV inventions. Beyond their subject-matter expertise and experience, EIRs/XIRs bring a desire to see potential entrepreneurs succeed and have proven to be a valuable asset in advancing university-based innovations toward the commercial marketplace.

EIRs/XIRs represent a wide array of entrepreneurial experience levels from founders to chief executives. They also bring a wealth of skills and a deep network of contacts in disciplines as diverse as finance, operations, human resources, marketing, and law. EIRs/XIRs and UNLV will

synergistically move technologies along the commercialization path and provide distinct resources in assessing technologies, mentoring entrepreneurial teams, locating funding sources, and securing physical locations.

EIR/XIR Goals

Concurrent with serving as a guide and mentor within the UNLV entrepreneurial community, each EIR/XIR is expected to identify a UNLV invention and create and lead a new startup venture that will license and commercialize that invention. Alternatively, they will identify and join a startup venture that is based on an already licensed UNLV invention. EIRs/XIRs are required to contribute their time, knowledge, skill set, subject matter expertise, etc. in a manner commensurate with the funding allocated to the specific project.

EA is comprised of a vast network of entrepreneurs, venture capitalists, angel investors, current and former C-level executives, subject-matter experts, and leaders within the business community. EA has identified several key members within their group to serve as EIRs/XIRs for this project collaboration with OED. See additional information regarding the EA team in Appendix A.

The ability to appoint EIR/XIRs has been impacted by restrictions related to COVID-19. As such, the EIR/XIRs program was largely scaled back during the reporting period and EIR/XIRs served as mentors and advisors through les formal engagements. Notwithstanding the foregoing, Mr. Rahul Harkawat of Entrepreneurs Assembly has served as the primary EIR/XIR for the purposes of this project.

Translational Grant Fund and Commercialization Validation

The Translational Grant Fund and commercialization validation initiative provides translational or "gap" funds to researchers and teams that are working on innovations that have high-potential for commercialization success. Such projects/innovations receiving funds under this program are reviewed and recommended by the De-Risking Teams.

During 2021, an open competitive RFP process was conducted to identify the most promising UNLV early-stage innovations that, with some translational funding, would quickly advance toward a status of "license ready" or "startup ready. Funds were prescribed for either technical development or could be used to support market research and market development, and to best understand the uniqueness/novelty of the invention in relation to its ability to fill market needs or solve an important problem.

Translational Grant Fund Goals

When administering the Translational Grant Fund and associated RFP, two notable requirements for receiving this funding include (i) the applicant must have an invention that has been previously disclosed to OED that is "active", and, (ii) the applicant must provide a commercial justification for the funds in addition to a technical or scientific justification.

In total, during calendar year 2021, the OED received 17 proposals requesting Translational Grant Fund funding. Each proposal was reviewed and ranked by a UNLV internal committee composed of technical, commercial and business subject matter experts as well as representatives from the Office of the Vice President for Research. In addition, external reviewers also ranked and

provided feedback on the submissions. External reviewers included EA, TAC, EIR/XIRs and subject matter experts.

The seventeen (17) applications that were received were then evaluated by a panel regarding criteria of:

1. **De-Risking** - does the project sufficiently de-risk the technology enough to get it to the next development level and make it commercially viable?
2. **Commercial Viability** - how likely is the technology to become a commercially viable product or service?
3. **Market Size** - how large is the market, industry, and demand (current and future) for the technology?
4. **Patentability** - how likely is it that the technology's intellectual property can be secured by a patent (useful, novel, and non-obvious)?

Results for internal and external reviews were aggregated with scoring and recommendations provided to the interim Vice President for Economic Development. Based on recommendations from the reviewers, and with approval of the interim Vice President for Economic Development, a total of 6 awards were granted to UNLV researchers. Basic information on all proposals received are as follows:

	Researchers	Proposal Title	Award Amount*
1	**Jun Kang**	**Cancer Treatment**	$27,734
2	**Jeremy Cho**	**Atmospheric Water Harvesting**	$27,734
3	**Ernesto Abel-Santos**	**Anti-Diarrheal**	$27,734
4	**Brian Hedlund**	**DNA Sequencing**	$27,734
5	**Zhiyong Wang**	**Disinfecting Air Containing Viruses**	$54,349
6	**Pradip Bhowmik**	**Fire Retardant Polymer**	$27,000
7	Michael Pravica	Reflective Light Device	NF
8	Bob Schill	EM Dots	NF
9	Jay Park	Sensor Vest	NF
10	Jaeyun Moon	Gamma Ray Detector	NF
11	Hui Zhang	Cancer Treatment	NF
12	Yen-Soon Kim Mingon Kang	Food Safety App	NF
13	Samir Moujaes	Automated Whiteboard Er	NF
14	Brendan O'Toole Maria Ramos	Knee Implant Testing Machine	NF
15	Kwang Kim	Flow Sensor	NF
16	Yoohwan Kim	SCADA Cybersecurity	NF
17	Shubhra Bansal	Solar Cells	NF

*Actual project spend may be different than Award Amount.

Information and funded outcomes of each funded project are detailed in Exhibit “A” of this report.

Project Progress

During the reporting term, UNLV has made significant progress toward meeting its proposed goals for this project. Major accomplishments for the current reporting period are outlined below:

Major Projects under Current Review:

Fire-Retardant Polymer

A license agreement between UNLV and NoFire Zone Inc. (dba Firesafe Zone) completed during December 2020 providing the licensee with exclusive worldwide rights to certain intellectual property developed by Dr. Pradip Bhowmik. The licensed technology covers a series of fire-retardant polymers with multiple potential applications. UNLV will receive certain payments under the license including a royalty on sales of the products that are covered under the licensed patents.

Current Firesafe Zone efforts are focused on the development of specific applications and uses of the fire-retardant polymer technology with a primary focus on textiles, construction materials, electronics and high-tech devices, and battery materials.

Current Reporting Period Highlights: Firesafe Zone, Inc. created 2 founder positions and 2 executive positions and has a full-time Director of Research. The company has been an active participant in seeking an NSF Innovation Engine grant as the only Nevada start-up to play a leading role in preparing the grant application. The company has revised its previous non-funded NSF-SBIR grant will resubmit in the last calendar quarter of 2022. During the reporting period the company received approximately $200,000 in external angel investment and is actively seeking up to $4.5million for its next funding series.

During the reporting period Firesafe Zone made significant progress toward building research and development partnerships with universities and companies globally. Some of these partnerships including IIT Madras, a leading Indian university with extensive capabilities and expertise in the fire-retardant polymer space, and the State of Wallonia Belgium where significant battery and polymer chemistry expertise reside. In addition, the company has made progress is partnering to obtain development and manufacturing capabilities necessary to further its research and development programs as well as commercial manufacturing of target products.

Additional highlights include FireSafe Zone creating a new subsidiary, Quantum Copper, Inc., that will utilize the fire-retardant polymer technology into new battery systems with a focus on improving non-active battery materials. The company has filed several patents related to this application and is working closely with UNLV researcher Dr. Bhowmik which should yield more innovations and/or intellectual property being developed at UNLV.

Lastly, it should be noted that during the reporting period FireSafe Zone, entered into a lease for office space located at the UNLV Harry Reid Research Park. This represents a significant step forward for the emerging company. The company continues to look for space to lease to support is technical and research operations.

Recovery of Li Salts and Rare Earth Metals from Ionic Solutions

During August 2020, EA and UNLV began a comprehensive review and assessment of several technologies related the recovery of lithium metal and certain rare earth metals from ionic solutions, based on methods and technology developed by Dr. David Hatchett. This review, and the identification of potential licensees has continued. This technology has potential application to recycling/recapturing metals found in lithium batteries that are common in automobiles and electronic devices. Current discussion between EA and UNLV includes developing a management team and forming a company that can further the development of this technology. Efforts to advance and commercialize this technology have continued during the reporting period.

Current Reporting Period Highlights:

Key updates from the reporting period include, with the strong support of the EA team, several additional potential licensees of the IP that covers the subject technology were identified and have been contacted. One of these partners, a chemical company based in Asia, has visited UNLV as part of their due diligence. UNLV and the company are in active discussions for a patent license. In addition, the company and UNLV are in active discussions around the company opening an operating subsidiary in Southern Nevada.

It should be noted that during the reporting period there have been ongoing discussions with four U.S. based companies, including one with a significant presence in Nevada, regarding the licensing of the technology. The prosecution of patent applications continues with both active and aggressive pursuit of international patents to protect the subject invention.

Other Project Developments:

Technology Patent Licenses

A license agreement granting certain patent rights to the Electrical Potential for Nano Manufacturing and Machining Difficult-To-Cut Materials invention was executed during May 2020. The license will require payment of a royalty to UNLV based on net sales of products by the licensee that rely on the licensed patent rights. It is not anticipated that royalties will be paid until sometime during the 2023 calendar year. During the reporting period the licensee confirmed its efforts to continue to develop products based on the licensed technology.

Licensing Discussions

During the reporting period, meaningful discussions resumed with a large laboratory equipment manufacturer that are focused on the potential licensing and commercialization of a unique innovation developed by Dr. Michael Pravica. This technology was reviewed and benefited from the de-risking program. The technology is generally titled “Reflective Light Device” and is a device and method for improved spectrometry observations. It is hoped that a license will be concluded in the next 90 days.

Engagement with EA

UNLV formally engaged EA to provide professional services necessary for the successful execution of this project. The formal engagement became effective July 23, 2019. Under that

relationship, UNLV shared information and documents with EA, on a confidential basis, related to university inventions. These documents include patent intellectual property filings, internal invention disclosures, and any other related research materials. EA provided an in-depth evaluation of each technology and made recommendations to increase commercial viability. Further, EA opened their network of subject matter and industry experts to UNLV to increase the likelihood of achieving intended commercial outcomes.

The relationship with formed under this project formally concluded on June 30, 2022. However, the "spirit" of this project continues and UNLV and EA remain in active communication with a focus on the identification and continued development of UNLV innovations that are believed to have commercial potential.

Budget

The following table provides project expenditures and the remaining budget for the reporting period. Expenditures included a payment to EA for professional services related to the evaluation and de-risking of UNLV innovations as well as funding provided under the Translational Grant Fund.

This project was extended in order to accomplish all goals and objective of the program. An extension of funds was granted extending the project through June 30, 2022.

Project Expenditures

Budget (Expended and/or obligated): $276,552 (92.2%)
Remaining Budget (Not expended or obligated): $23,448** (7.8%)

Project Expenditures
For Reporting Period
March 1, 2022 – August 31, 2022

	Program Budget	Actual Expenditures To Date	Actuals plus Obligations	Remaining Budget
Professional Services	$ 101,267	$ 101,264	$ 101,264	$ 3
Commercialization Grants	$ 192,285	$ 170,246	$ 170,246	$ 22,039**
Personnel Expenses	$ 6,448	$ 5,042	$ 5,042	$ 1,406
Total	**$ 300,000**	**$ 276,552**	**$ 276,552**	**$ 23,448**

** An obligation of $7,000 remains associated with this line/category item and is not shown in the amounts above as the invoice from that associated vendor was received after the June 30, 2022 funding period of this project.

For Reporting Period
March 1, 2022 – August 31, 2022

	Reporting Period Actuals	Previous Reporting Periods	Total
Technologies Assessed	0	39	**39**
Jobs Created	2	3	**5**
Businesses Created	1	1	**2**
Patent Applications Filed	3	5	**8**
Executed License Agreements	0	2	**2**

Additional Knowledge Fund Reporting Requirements

Public Benefit

This project will provide benefits to the public and the local community in the form of new businesses, job growth, and economic dynamism. New businesses are typically the primary source of job creation in the American economy. Newly created businesses also contribute to economic dynamism by injecting competition into markets and spurring innovation.

The Kauffman Foundation reports that businesses with fewer than 50 employees represent over 95% of all U.S. companies and these young startups are the firms most likely to lead to job creation. New businesses account for nearly all net new job creation and almost 20 percent of gross job creation. Additionally, companies less than one-year-old have created an average of 1.5 million jobs per year over the past three decades.[1]

By commercializing UNLV technologies through successful license agreements or the formation of startup companies, this project will foster innovation in the marketplace and create jobs with high growth potential for the local economy.

Research Faculty

All current UNLV research teams and faculty jobs have been retained during the project. This project has not resulted in the hiring of any additional UNLV research teams and faculty. Initial funds allocated to this project have been used to employ EA services related to the de-risking and evaluation of technologies, see the Budget section for additional information.

[1] https://www.kauffman.org/what-we-do/resources/entrepreneurship-policy-digest/the-importance-of-young-firms-for-economic-growth

It should be noted that as a result of the disbursement of funds through the Translational Grant Fund, several graduate students and undergraduate students were hired/supported with each contributing to the development of the funded projects.

Research Laboratories

During the project, there has not been any use of research laboratories or related equipment beyond that which is already being performed by current UNLV research faculty.

One of the most promising technological developments pertains to the Fire-Retardant Polymer technology where EA and FireSafe Zone are partnering with the State of Wallonia, Belgium and IIT Madras (India) to assist with the development of the proprietary polymer. FireSafe Zone his making efforts to find students with a connection to these locations to hire to work on the project.

Research Clinics, Institutes, and Facilities

There have not been any research clinics, institutes, facilities, or related buildings created as a result of the project.

Current Research Efforts

Funding allocated from the Knowledge Fund will be to provide translational "Gap-Funding" to UNLV researchers in support of projects identified as having high commercial potential. In total, six (6) projects were funded and continue to advance toward commercialization.

Patents and Intellectual Property

During the reporting period a total of three (3) new patent applications were filed targeted at three separate innovations as a result of this project. Each of the three applications was directed at subject inventions believed by the de-risking team to have potential of commercial success. Although this project is primarily focused on the commercialization of existing UNLV intellectual property the three new patent applications were necessary to increase the likelihood of finding a commercial development partner.

Research Grants, Gifts, and Donations for Research Teams

To date, no research grants, gifts, or donations have been received for this project. Notwithstanding the foregoing, several SBIR/STTR grant applications are currently being prepared. In addition, FireSafe, a Nevada start-up and licensee of certain UNLV patents, successfully raised $200,000 during the reporting period.

Research Grants, Gifts, and Donations for Knowledge Fund Account

To date, no research grants, gifts, or donations have been received for this project.

Federal and Private Grant Matching Funds and Contract Opportunities

There have not been any matching funds for federal or private sector grants or contract opportunities that support economic development as a result of this project.

Business Growth and Impact

In total two (2) business have been started as a result of this project; FireSafe Zone and Quantum Copper, Inc. It is anticipated that one additional patent license will be executed prior to the end of the calendar year. It is also noteworthy that UNLV and EA continue discussions with a large international based company related to establishing an operating entity in Southern Nevada.

Job Creation and Impact

Five new jobs were created to date as a result of this project. NoFire Zone, Inc. created two executive/founder positions along with two additional executive positions within their organization. Additionally, No-Fire has hired a Director of Research. All current EA employees and UNLV research faculty related to technologies that are being evaluated have been retained.

Workforce Development

No workforce development and training, such as certificate programs and degree programs, has been created as a result of this project.

Appendix A:

[Begins on next page]

UNLV - ECONOMIC DEVELOPMENT
GOED Technology Commercialization Project Report

REPORTING PERIOD: Start – June 30, 2022, Final

PI NAME: Jun Kang
DEPARTMENT: Chemistry and Biochemistry
PROJECT TITLE: Thiophosphoric Acids as Novel Organocatalysts and Synthetic Methods of Thiophosphonate derivatives as Pharmaceutical Agents
AWD OR GR ACCOUNT #:GR14820

PROJECT ACCOMPLISHMENTS/HIGHLIGHTS/SIGNIFICANT FINDINGS

Thiophosphate compounds bearing a phosphoryl bond display important biological activity for the treatment of cancer and glaucoma. They also have been shown to provide remarkable antibacterial properties against common strains of bacteria. Therefore, an efficient, mild methodology for the synthesis of thiophosphates and their derivatives is highly desirable and possess unmet need. This thiophosphoric acid project led to the discovery of new synthetic methodology which generates diaryl thiophosphates from 2-hydroxy phenylbenzenemethanols as potential APIs under metal-, chloride-free reaction conditions. This project also discovered a new chemical reagent of thiophosphoric acids as novel thiophosphorylation reagents which will be able to find a plethora of new synthetic methodology in the future. This project also identified new synthetic transformation which generates allyl thiophosphonates from allylic alcohols. These new compounds will be further studied as potential fire retardants since such chemicals are crucial components of NASA's standard for fire protection in manned missions.

RELEVANT MEETINGS/EVENTS/PRESENTATIONS

Because this project developed not only new chemical reagents but also novel APIs, it has been advanced to the stage of provisional patent application. There have been several meetings among UNLV Business Development Officers and patent attorneys, and there will be follow-up meetings for the patent application. The discovery from this project will be presented at OUR summer and fall symposium.

PUBLICATIONS (RELATED TO PROJECT)

A manuscript entitled "Catalyst-free thiophosphorylaiton of in-situ formed ortho-quinone methides" has been generated and will be submitted after a provisional patent application is filed.

RESEARCH FUNDING (RELATED TO PROJECT)

Other Research Grants Received/Pending
 # received: 1
$ amount of new awards: NSF-EPSCoR UROP

Donations (non-grant)
 # received: N/A
$ amount of donations: N/A

INTELLECTUAL PROPERTY (RELATED TO PROJECT)

Disclosures: Thiophosphoric Acids as Novel Organocatalysts and Synthetic Methods of Thiophosphonate derivatives as Pharmaceutical Agents
Patents Filed: pending
Patents Issued: N/A

FACULTY SUPPORT

# of faculty positions supported N/A
% of support for each (support $/salary = total) N/A

STUDENT DATA

 # New Students Hired with Project Funds: one graduate (Jeffery Ash) and one undergraduate (Choi Tsang)
 # New GA or Post-Docs Hired with Project Funds: N/A
$ Amount of Project Funding Expended on Student/GA Hires: $6,000

MAJOR PROBLEMS/ISSUES

Although we had generated sufficient data for publication and patent application, submission of the manuscript and provisional patent application was significantly delayed due to the shortage of license officers in the office. In addition, a budget limitation in the office could potentially prevent a high potential discovery from being protected.

BUDGET

Within Budget: ☒ Yes ☐ No
% of Funding Remaining: 2.32% ($643.16) of student wedge remained unused as the student missed the hourly lab work due to the health issue.

Please explain any variance in initial budget - why all funding was not expended OR please explain any overage in budget:

2.32% ($643.16) of student wedge remained unused as the student missed the hourly lab work due to the health issue.

UNLV - ECONOMIC DEVELOPMENT
GOED Technology Commercialization Project Report

REPORTING PERIOD: Start – June 30, 2022, Final

PI NAME: H Jeremy Cho
DEPARTMENT: Mechanical Engineering
PROJECT TITLE: Atmospheric water harvester using a gel with embedded salt
AWD OR GR ACCOUNT #:GR14818

PROJECT ACCOMPLISHMENTS/HIGHLIGHTS/SIGNIFICANT FINDINGS

Thanks to this funding, we were able to make great strides toward proving our water harvesting concept. The main performance outcome of this project is that we captured water from air at drier conditions than anybody else has (10% relative humidity). This means our technology demonstrably out-performs the state of the art, at least on small testing scales. To put this in perspective, if we scaled up our results and made a prototype the size of a few residential solar panels, we would be able to generate one person's daily drinking water requirement, just from the ambient air on even some of the driest days in Las Vegas. This exciting result will be published soon.

RELEVANT MEETINGS/EVENTS/PRESENTATIONS

We presented aspects of this work at two conferences:

H.J. Cho, Y. Gao, R.A. Phung, B. Navarro, G. Marcial-Lorza, S. Wachs, "Water transport through hydrogel membranes at low relative humidities," American Physical Society March Meeting, Chicago, IL, March 14–18, 2022.

Y. Gao, M.R. Mata Arenales, B. Navarro, S. Wachs, H.J. Cho, "Liquid Transport Properties through hydrogels," 2nd Conference on Micro Flow and Interfacial Phenomena, Irvine, CA, June 20–23, 2022.

PUBLICATIONS (RELATED TO PROJECT)

One paper has been submitted, but is under revision.

Y. Gao, H.J. Cho, "Hydrogel Noodle Soup: How Strand Spacing Relates Permeability to Stiffness," *in revision*.

Another paper that will present our latest findings of harvesting at low humidities is in preparation.

Y. Gao, R.A. Phung, H.J. Cho, "Continuous atmospheric water harvesting at extremely low humidities," *in preparation*.

RESEARCH FUNDING (RELATED TO PROJECT)

Other Research Grants Received/Pending
 # received: 0
$ amount of new awards: 1 NSF proposal in the amount of $596,489 has been submitted and is pending

Donations (non-grant)
 # received: 0
$ amount of donations: 0

INTELLECTUAL PROPERTY (RELATED TO PROJECT)

Disclosures: 1
Patents Filed: 0
Patents Issued: 0

FACULTY SUPPORT

# of faculty positions supported 1
% of support for each (support $/salary = total) 0 (no summer salary was taken)

STUDENT DATA

 # New Students Hired with Project Funds: 5
 # New GA or Post-Docs Hired with Project Funds: 0
$ Amount of Project Funding Expended on Student/GA Hires: $6,153.91

MAJOR PROBLEMS/ISSUES

No major problems or issues were encountered.

BUDGET

Within Budget: ☐ Yes ☒ No
% of Funding Remaining: -1.4%

Please explain any variance in initial budget - why all funding was not expended OR please explain any overage in budget:

There is a slight overage in budget ($28,120.09 spent vs $27,734.00 budgeted). This was due to difficulty in predicting hourly workers' hours so it seems $386.09 was overspent. Otherwise, the spending was very close to the original budgeted amounts.

UNLV - ECONOMIC DEVELOPMENT
GOED Technology Commercialization Project Report

REPORTING PERIOD: Start – June 30, 2022, Final

PI NAME: Ernesto Abel-Santos
DEPARTMENT: Chemistry and Biochemistry
PROJECT TITLE: NON-HYDROLYSABLE BILE SALTS AS PROPHYLACTICS OF C. DIFFICILE INFECTION
AWD OR GR ACCOUNT #:GR14819

PROJECT ACCOMPLISHMENTS/HIGHLIGHTS/SIGNIFICANT FINDINGS

To address the stability of anti-germinants, we examined analogs in which the amide was "incorporated" into aromatic heterocycles. We have termed these compounds non-hydrolysable bile salts (NHBS). Of this first group, the underivatized cholate quinazoline (CA-Quin), cholate benzimidazole (CA-BzIm), deoxycholate benzimidazole (DCA-BzIm), cholate benzothiazole (CA-BzTh), and cholate benzoxazole (CA-BzOx) inhibited *C. difficile* spore germination at low micromolar concentrations (**Table 1**). Similar to the cholan-24-amides containing *m*-sulfanilic acid (CamSA), or aniline (CaPA) [PMID: 34780262 and PMID: 23420906] , CA-Quin also prevented all CDI signs in mice from hypervirulent *C. difficile* strain R20291. Although CA-BzTh did not completely prevent CDI, it significantly reduced sign severity. Furthermore, whereas CamSA and CaPA were hydrolyzed by undisturbed murine microbiota [PMID: 34780262 and PMID: 33152344], CA-Quin was not degraded even after 3 days incubation with feces (data not shown). Fron these studies, we have also obtained tissue samples from treated animals. These samples will be analyzed at Wayne State University to determine the effect of these compounds on the liver and intestines. Our results indicate that non-hydrolysable heterocyclic bile salt analogs display anti-germinant and CDI prophylaxis activity, validating our hypothesis that heterocycles could be used to replace the amide group.

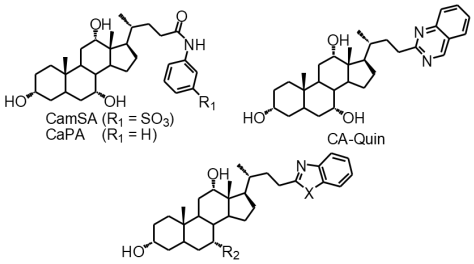

Table 1. Properties of NHBS lead compounds against hypervirulent *C. difficile* strain R20291

Name	*In vitro* anti-germination IC_{50} (μM)	Murine CDI prophylaxis at 50 mg/kg
CA-Quin	21.6 ± 2.6	Complete protection
CA-BzIm	4.4 ± 0.3	No protection
DCA-BzIm	5.6 ± 1.2	Not tested
CA-BzTh	5.9 ± 3.5	Partial protection
DCA-BzTh	Inactive	Not tested
CA-BzOx	5.8 ± 2.8	Not tested
DCA-BzOx	Inactive	Not tested

RELEVANT MEETINGS/EVENTS/PRESENTATIONS

JACKIE PHAN PRESENTED A POSTER AT THE 16TH BIENNIAL CONGRESS OF THE ANAEROBE SOCIETY OF THE AMERICAS (ANAEROBE 2022), MRS. phan wan first place in the young investigator's competition

PUBLICATIONS (RELATED TO PROJECT)

Click or tap here to enter text.

RESEARCH FUNDING (RELATED TO PROJECT)

Other Research Grants Received/Pending
 # received: These results also served as the basis for the renewal of R01 GRANT13695853 (submitted)
$ amount of new awards: Click or tap here to enter text.

Donations (non-grant)
 # received: Click or tap here to enter text.
$ amount of donations: Click or tap here to enter text.

INTELLECTUAL PROPERTY (RELATED TO PROJECT)

Disclosures: Click or tap here to enter text.
Patents Filed: These results have been submitted for provisional intellectual protection under application US 63/319,079 entitled "Inhibitors of C. difficile spore germination"
Patents Issued: Click or tap here to enter text.

FACULTY SUPPORT

# of faculty positions supported 0
% of support for each (support $/salary = total) 0

STUDENT DATA

 # New Students Hired with Project Funds: 0
 # New GA or Post-Docs Hired with Project Funds: 0
$ Amount of Project Funding Expended on Student/GA Hires: $13,911

MAJOR PROBLEMS/ISSUES

The project has a late start because funds disbursement was delayed. Because of this, we are still running animal experiments beyond the funding period. This has lead to over-expending that is been covered by other projects

BUDGET

Within Budget: ☒ Yes ☐ No
% of Funding Remaining: Click or tap here to enter text.

Please explain any variance in initial budget - why all funding was not expended OR please explain any overage in budget:

Click or tap here to enter text.

UNLV - ECONOMIC DEVELOPMENT
GOED Technology Commercialization Project Report

REPORTING PERIOD: Start – June 30, 2022, Final

PI NAME: Brian Hedlund
DEPARTMENT: School of Life Sciences
PROJECT TITLE: NOVEL ERROR-CORRECTING DNA POLYMASERASES FOR NEXT-GEN DNA SEQUENCING TECHNOLOGIES
AWD OR GR ACCOUNT #:GR14817

PROJECT ACCOMPLISHMENTS/HIGHLIGHTS/SIGNIFICANT FINDINGS

- A total of 9,445 uracil deglycosylase-DNA polymerase I (UDG-DNAP1) fusion enzymes have been discovered from our own and public DNA databases, representing ~4,800 gene clusters at 95% sequence identity. These enzymes have been previously unnoticed, yet they occur in all biomes on Earth.
- Almost all UDG-DNAP1 enzymes are located on viral genomes or other mobile elements that are difficult to identify unequivocally. They may play a role in defense against antiviral strategies (e.g., defense against host-directed uracil incorporation).
- The polymerase domains are monophyletic, indicating a single evolutionary origin distinct, but closely related to, bacterial DNA polymerases. The UDG domains are paraphyletic, suggesting either they are saturated due to high diversity and/or the UDG-DNAP1 enzymes originated multiple times by fusion of different UDG domains with a single lineage of DNA polymerase domains.
- Almost all UDG-DNAP1 enzymes also have a 5' to 3' exonuclease domain that is active. This is one of the proofreading domains.
- Both UDG and DNA polymerase domains are active. The enzyme removes uracils from DNA and synthesizes DNA from a single-stranded template.
- The full UDG-DNAP1 enzyme (UP19) is highly thermostable (active up to at least 92 °C). After two rounds of in vitro mutagenesis and selection, the DNA polymerase domain is active to at least 96 °C.
- The full UDG-DNAP1 enzyme (UP19) or the same enzyme minus the UDG domain is among the most accurate thermostable polymerases known. This enzyme (minus the UDG domain) may be commercially viable. We are currently designing DNA sequencing experiments to test the accuracy of this enzyme under a few different conditions as compared to commercial enzymes.
- Co-occurrence analysis shows two different clusters of genes that strongly co-occur and in many cases are syntenous with the UDG-DNAP1 gene. These co-occurring genes are being studied to try to understand the natural role of the UDG-DNAP1.

RELEVANT MEETINGS/EVENTS/PRESENTATIONS

NONE TO DATE

PUBLICATIONS (RELATED TO PROJECT)

NONE TO DATE BECAUSE THESE TAKE SOME TIME. (WE ARE PLANNING A COUPLE OF PUBLICATIONS, ONE OF WHICH WE WILL PLAN TO SUBMIT TO A HIGH-IMPACT JOURNAL – POSSIBLY NATURE MICROBIOLOGY (IMPACT FACTOR 31).)

RESEARCH FUNDING (RELATED TO PROJECT)

Other Research Grants Received/Pending
 # received: NIH Small Business Innovation Grant – Phase I
$ amount of new awards: 156,443

Donations (non-grant)
 # received: None
$ amount of donations: None

INTELLECTUAL PROPERTY (RELATED TO PROJECT)

Disclosures: NOVEL ERROR-CORRECTING DNA POLYMASERASES FOR NEXT-GEN DNA SEQUENCING TECHNOLOGIES
Patents Filed: None to date
Patents Issued: None to date

FACULTY SUPPORT

# of faculty positions supported 0
% of support for each (support $/salary = total) 0

STUDENT DATA

 # New Students Hired with Project Funds: 0
 # New GA or Post-Docs Hired with Project Funds: 0
$ Amount of Project Funding Expended on Student/GA Hires: 0

MAJOR PROBLEMS/ISSUES

The only significant problem we encountered is that we conducted in vitro mutagenesis with one of the UDG-polymerase fusion enzymes to increase thermostability. Although we could increase the thermostability of the polymerase domain, the UDG domain did not increase and is still below temperatures ideal for PCR and DNA sequencing. We are still investigating this issue but in the meantime we are optimizing the polymerase (with UDG domain removed) for next-gen DNA sequencing functions because it has an extremely high fidelity even without the UDG domain.

BUDGET

Within Budget: ☒ Yes ☐ No
% of Funding Remaining: 0

Please explain any variance in initial budget - why all funding was not expended OR please explain any overage in budget:

The full budget has been spent.

UNLV - ECONOMIC DEVELOPMENT
GOED Technology Commercialization Project Report

REPORTING PERIOD: Start – June 30, 2022, Final

PI NAME: Zhiyong Wang
DEPARTMENT: MEG
PROJECT TITLE: Disinfecting Air Containing Viruses from Ventilators, Sports Facilities, and Other Air Circulation Systems
AWD OR GR ACCOUNT #:GR11512

PROJECT ACCOMPLISHMENTS/HIGHLIGHTS/SIGNIFICANT FINDINGS

The project resulted several prototypes to trap Covid-19 viruses based on finding that the virus possesses positive charges, tests were performed in a level 2 lab at the University of Oregon, with negative results.

RELEVANT MEETINGS/EVENTS/PRESENTATIONS

MEETINGS WITH RESEARCHERS AT U OF OREGON DISCUSSED THE RESULTS, POSSIBLE CAUSE SUCH AS NO LIVE VIRUSES USED IN THE TEST DUE TO THEIR LEVEL II LAB LIMITATION WAS CONSIDERED. BOTH SIDE AGREES TO WORK ON RESEARCH FUNDINGS TO RUN MORE LAB TESTS.

PUBLICATIONS (RELATED TO PROJECT)

TO BE DECIDED DUE TO THE RESULTS IS NEGATIVE FROM U OF OREGON.

RESEARCH FUNDING (RELATED TO PROJECT)

Other Research Grants Received/Pending
 # received: 0
$ amount of new awards: 0

Donations (non-grant)
 # received: 0
$ amount of donations: 0

INTELLECTUAL PROPERTY (RELATED TO PROJECT)

Disclosures: 1
Patents Filed: 1
Patents Issued: unknown

FACULTY SUPPORT

# of faculty positions supported 1
% of support for each (support $/salary = total) 0.5m

STUDENT DATA

 # New Students Hired with Project Funds: 2
 # New GA or Post-Docs Hired with Project Funds: 0
$ Amount of Project Funding Expended on Student/GA Hires: 0

MAJOR PROBLEMS/ISSUES

Test on Covid-19 virus required highly regulated lab, the PI identified al level III lab at U of Texas, but unable to run the test due to budget shortage. The final lab test was performed at a level II lab at the U of Oregon, without live viruses allowed in the test.

BUDGET

Within Budget: ☒ Yes ☐ No
% of Funding Remaining: a little

Please explain any variance in initial budget - why all funding was not expended OR please explain any overage in budget:

1) Cost of lab test at the u of Oregon;
2) PI didn't draw 1 month summer salary but 0.5 m to preserve funding for lab test, which also made difference to the budget.

UNLV - ECONOMIC DEVELOPMENT
GOED Technology Commercialization Project Report

REPORTING PERIOD: Start – June 30, 2022, Final

PI NAME: Pradip Bhowmik (with David J. Irvin)
DEPARTMENT: Chemistry and Biochemistry
PROJECT TITLE: Scale-up and Testing of FR Polymer
AWD OR GR ACCOUNT #:GR11583

PROJECT ACCOMPLISHMENTS/HIGHLIGHTS/SIGNIFICANT FINDINGS

Since the beginning of the project, we have synthesized 250 g of polymer to be processed into samples for internal and external testing. The material is processed into thin films using a solvent-based process. the samples are between 1-6 mm thick of various lengths and widths depending upon the test. A summary of the completed work and sample preparation for the various test is below.

Internal UL 94 V testing: 10 samples of 3mm x 10mm x 150 mm were produced using a methanol casting process. A 20 wt% solution of polymer in methanol was produced by stirring at room temperature overnight. The solution was then transferred to plastic-coated steel molds and the molds were placed in a diffusion chamber. The chamber was charged with 100 ml of methanol to saturate the chamber to control the evaporation from the polymer samples. After 48 hours, the films were mostly dry (dry to the touch). They were then pressed flat and dried under vacuum.

The standard UL 94 V setup was assembled consisting of a Bunsen burner (in both 45° and 90° configurations) with a 20 mm flame and the polymer sample suspended vertically from a pivot arm with a cotton pad placed under the sample to catch drips. A video camera was used to measure all times and char lengths. The sample was pivoted such that 10 mm of the flame was covering the bottom of the sample. After 10 seconds, the sample was pivoted out of the flame and the time to extinguish was recorded (After flame 1 time). This same sample is exposed to the flame again for 10 seconds and then pivoted out of the flame and the time to extinguish was recorded (After flame 2 time). Also recorded is: if the flame reaches the top of the sample and if there are any drop that do or do not set the cotton on fire. All samples passed with the highest rating V-0.

Samples have been or are being sent out for Surface resistivity & volume resistivity, cone calorimetry, and external UL 94 V and we should have all of these back by the next reporting period.

Observations: 45° testing After flame time 1: <1 second; After flame time 2: <1 second; no drips, no flame on cotton. Results: V-0 rating

Figure 1: Test and Result After Two Burn Tests with 45° Bunsen Burner

Observations: 90° testing After flame time 1: <1 second; After flame time 2: <1 second; no drips, no flame on cotton. Results: V-0 rating

Figure 2: Test and Result After Two Burn Tests with 90° Bunsen Burner

RELEVANT MEETINGS/EVENTS/PRESENTATIONS

Prof. Jennifer Irvin and I attended the ACS 2022 Fire and Polymers Workshop June 5-8, 2022, Napa, CA (USA) (https://www.polyacs.net/22fipo)

Poster - David J. Irvin, Kousaalya Bakthavatchalam, Rahul Harkawat, and Jennifer A. Irvin "Scale-Up and Testing of New Self-Extinguishing Polymer")

PUBLICATIONS (RELATED TO PROJECT)

NONE AT THIS TIME

RESEARCH FUNDING (RELATED TO PROJECT)

Other Research Grants Received/Pending
 # received: NONE
$ amount of new awards: NA

Donations (non-grant)
 # received: Click or tap here to enter text.
$ amount of donations: Click or tap here to enter text.

INTELLECTUAL PROPERTY (RELATED TO PROJECT)

Disclosures: 0 disclosures
Patents Filed: 2 patents
Patents Issued:) patent issued

FACULTY SUPPORT

# of faculty positions supported None
% of support for each (support $/salary = total) None

STUDENT DATA

 # New Students Hired with Project Funds: None
 # New GA or Post-Docs Hired with Project Funds: None
$ Amount of Project Funding Expended on Student/GA Hires: None

MAJOR PROBLEMS/ISSUES

No major issues. Minor time delays due to travel and illness.

BUDGET

Within Budget: ☒ Yes ☐ No

% of Funding Remaining: $7000. An invoice to $6000 will be submitted after all samples have been sent out, and the remain $1000 will be invoiced after a final report has been submitted.

Please explain any variance in initial budget - why all funding was not expended OR please explain any overage in budget:

NA - On budget.