FCR 14

Office of the President
June 16, 2023

Members, Board of Trustees:

PATENT ASSIGNMENT REPORT

Recommendation: that the Board of Trustees accept the patent assignment report for the period January 1, 2023 to March 31, 2023.

Background: At its March 1997 meeting, the Board of Trustees authorized the University of Kentucky Research Foundation to conduct all future copyright and patent filings and prosecutions. Quarterly reports on patent and copyright applications are to be submitted to the Finance Committee of the Board.

Action taken: ☑ Approved ☐ Disapproved ☐ Other _____

PATENT ASSIGNMENTS
FOR THE PERIOD January 1, 2023 TO March 31, 2023

Patents

The following assignments on behalf of the Board of Trustees of the University of Kentucky Research Foundation have been executed:

1. **U.S. Patent Application Number:** 18/006,193
UKRFID: 2493
Filed: January 20, 2023
Title: METHOD OF MULTI-STAGE FRACTURING OF SUBTERRANEAN FORMATION AND SLURRY FOR THAT METHOD
Inventors: Thomas Robl, Robert Jewell, Anne Oberlink and Tristana Duvallet (Center for Applied Energy Research)
Description and Application: This is a method of hydraulic fracturing a subterranean formation by injecting a first proppant made from coal combustion fly ash particles with a mean particle size of 6 to 8 microns. The method may also include the injection of a second proppant made from coal combustion fly ash particles with a mean particle size of 25 to 35 µm. A third fly ash derived proppant, with a mean particle size of 70 to 80 µm, may also be used. The global proppant market is estimated to reach $7.8 billion by 2020 and is expected to reach $12.1 billion by 2025.
License: Optioned to Enhanced Solution Services LLC

2. **U.S. Patent Application Number:** 18/006,889
UKRFID: 2488
Filed: January 26, 2023
Title: ACCELERATING REPAIR OF MUCOSAL INJURY USING GOLD(III) COMPOUNDS
Inventors: Samuel Awuah (College of Arts and Sciences) and Terrence Barrett (College of Medicine)
Description and Application: This is a method for treating inflammatory bowel disease (IBD) and coronavirus-induced enteritis by increasing mitochondrial respiration in a cell. Mitochondrial respiration is increased by administering a novel gold(III) compound to a subject. IBD is a chronic illness that is estimated to affect more than 3.1 million patients in the United States. IBD requires costly lifelong medical therapy and frequently results in hospitalization, surgery and disability.

The global market for IBD treatment was $13 billion in 2020 and is expected to reach $15 billion by 2027, with a Compound Annual Growth Rate (CAGR) of 2.3%.
License: N/A

3. **U.S. Patent Application Number:** 18/006,895
UKRFID: 2490
Filed: January 26, 2023
Title: GOLD(III) COMPOUNDS AND CANCER CELL-SELECTIVE MODULATION OF MITOCHONDRIAL RESPIRATION AND METABOLISM
Inventors: Samuel Awuah and Randall Mertens (College of Arts and Sciences)
Description and Application: These novel gold(III) compounds are used to treat cancer by perturbing mitochondrial metabolism. The novel compounds induce mitochondrial stress regardless of tumor type and are selective for cancer cells compared to normal cells. The oncology drug market was $128 billion in 2019 and is projected to reach $222 billion by 2027, with a CAGR of 7.4%.
License: N/A

4. **U.S. Patent Application Number:** 18/101,777
UKRFID: 2639
Filed: January 26, 2023
Title: ENRICHMENT OF IRON FROM BAUXITE WASTE IN CHEMICAL LOOPING COMBUSTION
Inventors: Kunlei Liu, Xin Gao, Ayokunle Omosebi, Neng Huang and Dimitrios Koumoulis (Center for Applied Energy Research)
Description and Application: This is a novel method and apparatus for the enrichment of iron from bauxite waste using chemical looping combustion (CLC). The method includes: (a) calcining particles of bauxite waste to form oxygen carrier particles, (b) subjecting the oxygen carrier particles to CLC at a temperature of 950°C to 1,050°C to produce energy and enriched iron fines as a by-product from the oxygen carrier particles via natural attrition, and (c) collecting the enriched iron fines that are emitted from fluidized processes by filtering. The global iron market is estimated to reach $423 billion by 2028.
License: N/A

5. **U.S. Patent Application Number:** 18/040,967
UKRFID: 2514
Filed: February 7, 2023
Title: GENERATION OF HYDROGEN BY THERMAL HYDROLYSIS OF SODIUM BOROHYDRIDES
Inventors: Hyun-Tae Hwang and Geo-Jong Kim (College of Engineering)
Description and Application: This is a method of generating hydrogen by heating a mixture of sodium borohydride and a water storage agent (that is stable below 60°C) to a temperature range between 80°C and 300°C to release water from the water storage agent and generate hydrogen. This novel method of hydrogen generation by thermal hydrolysis of sodium borohydride uses solid-state reactants to obtain high hydrogen yield at temperatures below 150°C and provides rapid kinetics without the use of a catalyst. The global market for hydrogen generation is $142 billion and is expected to grow with a CAGR of 8%.
License: Option in negotiation with KeumKang CNT Co.

6. **U.S. Patent Application Number:** 18/169,158
UKRFID: 2296
Filed: February 14, 2023
Title: PROTEASOME INHIBITORS
Inventors: Kyung Bo Kim, Zachary Miller, Deepak Bhattarai (College of Pharmacy) and Min Jae Lee (formerly College of Pharmacy)
Description and Application: This is a new class of peptide epoxyketones containing cyclic peptide backbones that selectively inhibit the immunoproteasome. The inhibition of immunoproteasome ameliorates the progression of neurodegenerative diseases such as Alzheimer's disease (AD) and age-related macular degeneration (AMD). This new class of peptide epoxyketones has a unique cyclic peptide backbone. Unlike current proteasome inhibitors, including FDA-approved proteasome inhibitors (carfilzomib, bortezomib, ixazomib) that are susceptible to peptidases, these proteasome inhibitors with a cyclic peptide backbone component are relatively resistant to peptidases, potentially improving metabolic stability and other properties. The current global market for proteasome inhibitors is more than $1.7 billion with an expected CAGR of 8% until 2023 (46% of the expected growth will come from North America).
License: Exclusive option to Arisu Therapeutics

7. **U.S. Patent Application Number:** 18/183,110
UKRFID: 1935
Filed: March 13, 2023
Title: COMPOSITIONS AND METHODS FOR TREATING RETINAL DEGRADATION
Inventors: Jayakrishna Ambati, Kameshwari Ambati and Benjamin Fowler (formerly College of Medicine)
Description and Application: These are methods to treat degradation of the retinal pigment epithelium (RPE) by administering compositions with a nucleoside and/or a nucleoside reverse transcriptase inhibitor (NRTI). Geographic atrophy, an advanced form of age-related macular degeneration, causes blindness in millions of people worldwide. There are no approved treatments, and it results from death of RPE cells. This treatment to reduce RPE cell death includes: 1) inhibiting inflammasome activation, 2) reducing permeability of a cell, 3) reducing the amount of mitochondrial reactive oxygen species in the cell and/or 4) inhibiting activation of at least one inflammasome in a subject's eye. The global pharmaceutical market for age-related macular degeneration was $8.6 billion in 2018 and is expected to reach $18.7 billion in 2028.
License: Exclusive license with Inflammasome Therapeutics, Inc.

8. **U.S. Patent Application Number:** 18/125,614
UKRFID: 2628
Filed: March 23, 2023
Title: Dual-Loop Solution-Based Carbon Capture System And Method
Inventors: Kunlei Liu, Xin Gao and Heather Nikolic (Center for Applied Energy Research)
Description and Application: The invention is a dual-loop solution-based carbon capture system. The system includes a single absorber, a stripper, polishing circuit, and a water washing circuit. The absorber has an organic solvent carbon dioxide capture section. The invention can lower capital costs by as much as 50% and offset operating cost with negative carbon dioxide emissions and hydrogen production, while minimizing amine-based solvent degradation. The global market for carbon capture was $2.4 billion in 2022 and is projected to reach $4.9 billion by 2027 with a 15.1% CAGR.
License: Optioned to Valiidun, Inc.

9. **U.S. Patent Application Number:** 18/029,057
UKRFID: 2492
Filed: March 28, 2023
Title: MULTI-COORDINATE GOLD-PHOSPHINE COMPOUNDS
Inventors: Samuel Awuah and Jong Hyun Kim (College of Arts and Sciences)
Description and Application: These novel gold-phosphine compounds are used to treat cancer by specific inhibition or uncoupling of mitochondrial respiration. In addition, the novel compounds can target distinct mitochondrial dynamics, such as mitochondrial structure to exert profound antitumor effects. These compounds are stable toward biological thiols and demonstrate enhanced mitochondrial oxygen consumption rates and induce proton leaking in aggressive cancer cells. The oncology drug market was $128 billion in 2019 and is projected to reach $222 billion by 2027, with a CAGR of 7.4%.
License: N/A

10. **International Application Number:** PCT/US2023/60841
UKRFID: 2599
Filed: January 18, 2023
Title: COMPOSITIONS, METHODS, AND DEVELOPMENT OF ARID4B INHIBITORS
Inventors: Samuel Awuah, Samuel Ofori (College of Arts and Sciences) and Mei-Yi Wu (George Washington University)
Description and Application: These are novel classes of compounds that bind to the chromo-barrel domain at AT-rich interactive domain 4B (ARID4B) to treat breast cancer. Large-scale genomic analyses of breast cancer datasets show that ARID4B is amplified in breast cancer. The novel compounds are derivatives of ARD150. The global market for breast cancer treatment was $31.9 billion in 2022 and is expected to reach $70.5 billion by 2030, with a CAGR of 10.4%.
License: N/A

11. **International Application Number:** PCT/US2023/62120
UKRFID: 2771
Filed: February 7, 2023
Title: SMALL COILS FOR AN ELECTRIC MOTOR
Inventors: Jiangbiao He (College of Engineering), Behrooz Mirafzal and Fariba Fateh (Kansas State University)

Description and Application: The invention is a novel electric motor with adjustable speed controlled by a switched drive or inverter. The novel motor includes a rotor, stator winding, cable and motor controller. The rotor is configured to be coupled to a mechanical load. The stator winding includes an adaptive impedance circuit connected in parallel with an inductive coil. A wide-bandgap transistor is configured to close when an overvoltage is detected. The global electric motor market was $113 billion in 2021 and is expected to reach $182 billion by 2028, with a CAGR of 7%.
License: N/A

12. **International Application Number:** PCT/US2023/14254
UKRFID: 2454
Filed: March 1, 2023
Title: PRINCIPLES OF OPERATION AND CONTROL OF OXIDIZER IN COUNTERCURRENT LEACHING CONFIGURATIONS
Inventors: Joshua Werner and Peijia Lin (College of Engineering)
Description and Application: The invention is a novel method to extract copper, gold and other elements of value from electronic-waste (e-waste) materials and copper bearing products. The method broadly includes the steps of: (a) contacting the feed material with a lixivant to leach the target metal, (b) providing a countercurrent flow in the leaching circuit, (c) determine a reagent consumption rate for each leaching vessel, and (d) recovering the target metal from the lixivant. The global market for e-waste was $52 billion in 2021 and is expected to reach $145 billion by 2030, with an expected CAGR of 13%.
License: Licensed of Neocycl Holdings, Inc.

13. **International Application Number:** PCT/US2023/63583
UKRFID: 2576
Filed: March 2, 2023
Title: END-SUBSTITUTED (HETERO)ACENES WITH PAIRWISE COUPLING IN CRYSTALLINE FORM FOR PURE SPIN POLARIZATION AND OPTICAL READOUT
Inventors: John Anthony, Karl Thorley (Center for Applied Energy Research), Emma Holland (formerly Center for Applied Energy Research), Brandon Rugg, Justin Johnson and Brain Fluegel (National Renewable Energy Laboratory)
Description and Application: These are novel crystalline (hetero) acenes as pairs of oriented molecules that undergo singlet

fission to generate spin-polarized triplet pairs with high emission efficiency at low temperature. These novel compounds may be used in quantum computation and quantum sensing. The global market for quantum computing is $866 million in 2023 and is expected to reach $4.4 billion by 2028, with an expected CAGR of 38%.
License: N/A

14. **International Application Number:** PCT/US2023/64707
UKRFID: 2645
Filed: March 20, 2023
Title: BONE BIOPSY ASSEMBLY WITH LOST MOTION RECEIVER
Inventors: Madhumathi Rao, Clay Larkin and Florence Lima (College of Medicine)
Description and Application: The invention is a novel bone biopsy needle designed to sample bone with minimal damage to microarchitecture and surrounding tissue. The novel needle is used in conjunction with a power tool to minimize the force required during the procedure. The global osteoporosis diagnostic market is approximately $455 million, with an expected CAGR of 4.1%.
License: N/A

15. **Foreign Application Number:** CN2023100534879
UKRFID: 2122
Filed: February 3, 2023
Title: PROSTAGLANDIN E SYNTHASE INHIBITORS AND METHODS FOR UTILIZING THE SAME
Inventors: Chang-Guo Zhan, Fang Zheng, Ziyuan Zhou (College of Pharmacy) and Kai Ding (College of Arts and Sciences)
Description and Application: This invention includes novel microsomal prostaglandin E synthase (mPGES-1) inhibitors and their use in treating inflammatory disorders. Currently available non-steroidal anti-inflammatory drugs (NSAIDs) inhibit either cyclooxygenase (COX)-1 or COX-2 or both. These inhibitors have side effects including ulcers, gastrointestinal tract bleeding or increased risk of cardiovascular events. Current studies indicate that the novel compounds have no similar side effects. The global market for anti-inflammatory therapeutics is expected to reach $125 billion by 2028.
License: N/A

16. **Foreign Application Number:** KR10-2023-7008642
UKRFID: 2514
Filed: March 13, 2023
Title: GENERATION OF HYDROGEN BY THERMAL HYDROLYSIS OF SODIUM BOROHYDRIDES
Inventors: Hyun-Tae Hwang and Geo-Jong Kim (College of Engineering)
Description and Application: This is a method of generating hydrogen by heating a mixture of sodium borohydride and a water storage agent (that is stable below 60°C) to a temperature range between 80°C and 300°C to release water from the water storage agent and generate hydrogen. This novel method of hydrogen generation by thermal hydrolysis of sodium borohydride uses solid-state reactants to obtain high hydrogen yield at temperatures below 150°C and provides rapid kinetics without the use of a catalyst. The global market for hydrogen generation is $142 billion and is expected to grow with a CAGR of 8%.
License: Option in negotiation with KeumKang CNT Co.

Patent Activities
Fiscal Year to Date as of March 2023

Total FY2022-23					
	FY23Q1	FY23Q2	FY23Q3	FY23Q4	Total FY23
Invention Disclosures[i]	24[1]	34	30	0	88
Full Patent Applications[ii]	23	14	16	0	53
Provisional Patent Applications[iii]	23	20	23	0	66
Patents Issued	8	6	11	0	25
License Income	$317,370.67	$172,263.56	$103,698.50	$0	$593,332.73
New Licenses and Options Executed	7	5[2]	13	0	25
New UK Startups Formed	3	0	1	0	4

[1] Additional Disclosure added to Q1 to capture disclosure that was entered after provisional application filed.
[2] Added additional license due to archived agreement.

Patent Activities
FY2021-22 as of June 30, 2022

Total FY2021-22					
	FY22Q1	FY22Q2	FY22Q3	FY22Q4	Total FY22
Invention Disclosures	13	20	25	33	91
Full Patent Applications	24	20	19	12	75
Provisional Patent Applications	18	21	13	16	68
Patents Issued	9	12	5	6	32
License Income	$925,684.76	$73,397.91	$204,789.15	$91,141.99	$1,295,013.81
New Licenses and Options Executed	8	2	10	10	30
New UK Startups Formed	0	1	2	1	4

Patent Application Summary Table

Inventors	College(s)	Title	Brief description
Biomedical			
Kyung Bo Kim, Zachary Miller, Deepak Bhattarai and Min Jae Lee	College of Pharmacy	Proteasome inhibitors	A novel drug to treat Alzheimer's disease and age-related macular degeneration.
Jayakrishna Ambati, Kameshwari Ambati and Benjamin Fowler	College of Medicine	Compositions and methods for treating retinal degradation	A method to treat degradation of the retinal pigment epithelium.
Madhumathi Rao, Clay Larkin and Florence Lima	College of Medicine	Bone biopsy assembly with lost motion receiver	A novel bone biopsy needle designed to sample bone with minimal damage to surrounding tissue.
Chang-Guo Zhan, Fang Zheng, Ziyuan Zhou and Kai Ding	College of Pharmacy	Prostaglandin E synthase inhibitors and methods for utilizing the same	Novel microsomal prostaglandin E synthase inhibitors to treat inflammatory disorders.

Inventors	College(s)	Title	Brief description
Engineering			
Hyun-Tae Hwang and Geo-Jong Kim	College of Engineering	Generation of hydrogen by thermal hydrolysis of sodium borohydrides	A method of generating hydrogen using sodium borohydride and a water storage agent.
Jiangbiao He	College of Engineering	Small coils for an electric motor	A novel electric motor with adjustable speed controlled by a switched drive or inverter.
Joshua Werner and Peijia Lin	College of Engineering	Principles of operation and control of oxidizer in countercurrent leaching configurations	A novel method for the extraction of gold and copper from e-waste.
Hyun-Tae Hwang and Geo-Jong Kim	College of Engineering	Generation of hydrogen by thermal hydrolysis of sodium borohydrides	A novel method of generating hydrogen using sodium borohydride.
Center of Applied Energy Research			
Thomas Robl, Robert Jewell, Anne Oberlink and Tristana Duvallet	Center for Applied Energy Research	Method of multi-stage fracturing of subterranean formation and slurry for that method	A method of hydraulic fracturing a subterranean formation by injecting proppant made of fly ash, a coal waste product.

Inventors	College(s)	Title	Brief description
Kunlei Liu, Xin Gao, Ayokunle Omosebi, Neng Huang and Dimitrios Koumoulis	Center for Applied Energy Research	Enrichment of iron from bauxite waste in chemical looping combustion	A novel method and apparatus to enrich iron from bauxite waste.
Kunlei Liu, Xin Gao and Heather Nikolic	Center for Applied Energy Research	Dual-loop solution-based carbon capture system and method	A dual loop solution-based carbon capture system.
John Anthony, Karl Thorley and Emma Holland	Center for Applied Energy Research	End-substituted (hetero) acenes with pairwise coupling in crystalline form for pure spin polarization and optical readout	Novel crystalline (hetero)acenes for use in quantum computers and quantum sensing.
Inventors	**College(s)**	**Title**	**Brief description**
Arts and Sciences			
Samuel Awuah and Terrence Barrett	College of Arts and Sciences	Accelerating repair of mucosal injury using gold(iii) compounds	A method to treat inflammatory bowel disease by increasing mitochondrial respiration.
Samuel Awuah and Randall Mertens	College of Arts and Sciences	Gold(III) compounds and cancer cell-selective modulation of mitochondrial respiration and metabolism	Novel gold(III) compounds to treat cancer.

Inventors	College(s)	Title	Brief description
Samuel Awuah and Jong Hyun Kim	College of Arts and Sciences	Multi-coordinate gold-phosphine compounds	Novel gold-phosphine compounds to treat cancer.
Samuel Awuah and Samuel Ofori	College of Arts and Sciences	Compositions, methods, and development of ARID4B inhibitors	Novel compound to treat breast cancer.

[i] Invention disclosures include new technologies and intellectual property disclosed to the Office of Technology Commercialization (OTC) that do not fall under an existing technology number. This number captures the potential new intellectual property disclosed to OTC.

[ii] Full patent applications, as used by OTC, include nonprovisional patent application filings at the United States Patent and Trademark Office (USPTO), Patent Cooperation Treaty filings, and foreign patent application filings. These are technologies that are assigned to the University of Kentucky that OTC has identified to invest further into in an effort to obtain patent protection and are described in more detail in the patent assignment section above.

[iii] Provisional patent applications are legal documents filed at the USPTO that establish a filing date and protect the owner from anticipated publication of the technology, but do not mature into an issued patent unless the applicant files a full patent application within one year. Although owned by the University of Kentucky, the provisional patent applications are not included in the patent assignment descriptions as they will not mature into full patent applications without further action and investment.