Mohammed Naziru Issahaq

146 Arnold Dr. Apt. 14, West Lafayette, IN. 47906.

Phone: (765) 607 9824. Email: missahaq@purdue.edu

01/08/2021

The Administrators,

Black Trailblazers in Engineering,

Purdue University. IN

Dear Administrator,

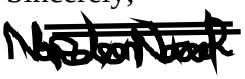
It is a privilege to apply to be a faculty trailblazer in the Black Trailblazers in Engineering (BTE) program at Purdue. I am a Ph.D. candidate in the school of Materials Engineering and due to graduate in May 2021. My dissertation which is under the direction of Professor Kevin P. Trumble, is focused on the metallurgy and shear deformation behavior of nonferrous metals. While on this project, I was engaged as a Teaching Assistant for two separate semesters (spring 2019 and Fall 2020) to assist the principal professors in a supplementary teaching role for the introductory level course to Materials Engineering (Structures and Properties of Materials). In this role, my tasks were to recap on the main lecture material for each week by providing relatable perspectives of the concepts that were difficult to follow in the main lectures. I also held weekly office hours to further discuss the pertinent problems of students, administered assignments, graded them and provided feedback to the students. I also served as a mentor to undergraduate seniors by providing research and professional guidance to the students.

Prior to graduate school, I worked as a Process Superintendent and Business Improvement Analyst in two separate gold mining companies for 4 years in Ghana, West Africa. The decision to quit these jobs for graduate school was to equip myself with the requisite knowledge to fulfil my long standing dream of becoming a faculty in academia. My combined experiences in academia and industry provide me with varied perspectives to relate with students in a more productive manner.

As an African aspiring to be a trailblazing faculty in engineering, there are many challenges including funding resources for research proposals and general exposure to the academic landscape in the country. The BTE program will be a useful avenue to interact with experienced Trailblazers and to get the lay of the academic land that will help set me up for success as a faculty in engineering.

Further details of my experiences and academic goals are stated in my CV and Research Statement. I hope and pray for a positive response to my application. Thank you for your consideration.

Sincerely,



Mohammed Naziru Issahaq

Research Statement

"The ideal engineer is a composite … He is not a scientist, he is not a mathematician, he is not a sociologist or a writer; but he may use the knowledge and techniques of any or all of these disciplines in solving engineering problems." - Nathan W. Dougherty, American Civil Engineer

Advanced production technologies in the manufacturing of large quantities of industrial components features deformation processing by machining either directly or indirectly. Deformation by machining is a concentrated shear-based process that involves the interaction of a hard cutting tool with a metal workpiece to remove material in the form of a chip. The chip can be the purposive part in cases like sheet and strip making or the valueless part when creating complex shapes and designs in the workpiece. There are many different machining techniques but among them is the orthogonal cutting model also known as Free Machining (FM). The orthogonal cutting model has been widely investigated within the last century. Our research group at the Materials Engineering Department and the Center for Materials Processing and Tribology in Purdue University, have been focused on different aspects of machining including a modified version of the FM model that is designed to combine both cutting and extrusion in a single step, high strain deformation. A technique referred to as Hybrid Cutting Extrusion (HCE).

HCE generally relates to methods of producing bulk forms at large strains with controllable microstructures and crystallographic textures. The principal benefits that can be gained from the HCE technique is microstructural refinement, improved mechanical and physical properties. The technique has been successfully used on many different alloys including alloys of Cu, Al, Fe and Mg to tackle some specific challenges that are encountered in using the FM technique. For instance, HCP magnesium has poor workability at room temperature which results in problems of segmentation during FM deformation. But with the capabilities of LSEM, the workability of Mg can be improved significantly to suppress segmentation and produce continuous chips. The pilot work of HCE on aluminum considered alloys from the 5xxx, 6xxx and 7xxx series. To extend the reach of the technique to the other aluminum alloy systems, my research focuses on applying the HCE technique to the commercially pure (1xxx) aluminum alloys.

Prior to HCE, FM is typically conducted to understand the natural flow response of the material. The challenge however, in working with the commercially pure alloys is that, they behave in a

“gummy” fashion during machining. The mode of plastic flow during the deformation is a direct consequence of the nature of the chips that are produced. In hard metals, the deformation is typified by ductile failure and shear banding resulting in chips with segmented and saw-tooth surfaces. In soft and ductile metals, machining is bewildered by high flow instabilities leading to large redundant strain and high cutting forces. Thus, producing chips of high thickness with uneven free surfaces (poor surface finishes).

Through in situ imaging and Particle Image Velocimetric (PIV) analysis, we demonstrated the wiggly flow behavior of the soft materials using streaklines virtually overlaid on the work material during the deformation. Whereas the wiggly flow mechanism provides useful Information on the fundamental science behind the material flow in machining, it poses numerous challenges to the quality of the chips and the mechanical and physical properties of these chips. Therefore, further work is being done to characterize the chips surface quality through surface metrology. An aspect of the study also explores ways of suppressing the flow instabilities by varying both the material conditions through microstructural modifications, and the deformation conditions. The results from some of these studies have been published in *ASME Journal of Manufacturing Science and Technology*. The results have also been presented to both Materials Science and Technology (MS&T) and The Minerals, Metals and Materials Society (TMS) conferences. Manuscripts of other aspects of these studies are also currently being reviewed for publications.

The expertise in materials engineering goes beyond the fabrication of materials and understanding the properties of these materials. The development of cost-effective techniques to process and fabricate advanced materials that meet the demands of our rapidly changing environment is as important as the science itself. Our research on HCE has not been extended to the economics of the process yet and therefore, beyond my Ph.D., I am looking to continue my research on the cost implications of the process. Other research areas that are of interest to me includes but not limited to microstructural development and characterization, nanostructured materials, powder metallurgy, additive manufacturing, Light-weight and energy-efficient structural materials.

Curriculum Vitae

MOHAMMED NAZIRU ISSAHAQ
146 Arnold Dr. Apt. 14, West Lafayette, IN. 47906.
Phone: (765) 607 9824. Email: missahaq@purdue.edu
https://www.linkedin.com/in/issahaq-mohammed-naziru-b555a05b

PROFESSIONAL SUMMARY

An ardent data science, materials and mining engineering professional with 8+ years of combined experience in advanced academic research, teaching and industry. Aiming to leverage my skills for the advancement of knowledge through research and development.

EDUCATION

Ph.D., Materials Engineering **Dec 2020.**
Purdue University, West Lafayette, IN.
DISSERTATION: *Hybrid Cutting - Extrusion of Commercially Pure Aluminum Alloys*.

B.S. Mining Engineering **July 2012.**
University of Mines and Technology, Tarkwa, Western Region, Ghana,
FINAL PROJECT: *Economic Analysis of Truck Haulage System of Bauxite from Awaso to Takoradi Harbor*

RESEARCH / TEACHING EXPERIENCE

Graduate Teaching Assistant **Aug. 2016 to Dec. 2020**
Purdue University, West Lafayette, IN.

- Taught Fundamentals of Materials Engineering to undergraduate students of diverse engineering backgrounds for student size of 100+ students (Spring 2019 and Fall 2020).
- Delivered in-class lectures on weekly basis, administered, proctored and graded student assignments and examinations.
- Under Covid-19 conditions, provided virtual lectures through Kaltura on Brightspace, virtual office hours through zoom conferencing and constantly reminded and encouraged students to follow all safety guidelines to avoid contracting the disease.
- Designed a course for metallurgical processing of metals
- Taught and supervised undergraduate students through experiments in the laboratory and assisting them with technical report writing and presentations.

Graduate Research Assistant **Aug. 2016 to Dec. 2020**
Purdue University, West Lafayette, IN,

- Specialized in the development and processing of high strength, high electrical conductivity and high temperature non-ferrous alloys through microstructural development in casting, solidification, solution heat treatment and deformation processing.
- Demonstrated the feasibility of using concentrated shear, hybrid cutting and extrusion deformation technique to suppress flow instabilities that are intrinsic to soft and ductile ("gummy") metals during machining.

- Produce aluminum electrical conductor wires of high strength and superior surface finish compared to conventional multi-step cold rolling and wire drawing by employing a single-step machining-based deformation.
- Developed a process map that addresses multiscale surface folding resulting from flow instabilities in the machining of soft aluminum and copper alloys using high speed imaging, particle image velocimetry and 3D surface profilometry.
- Examined solute-solvent interactions in phase transformation and defect formation in high electrical conductor alloys to demonstrate that solutes in solution are more injurious to electrical properties of metals than solutes out of solution.
- Practiced and enforced housekeeping practices and the implementation of general safety standards in laboratory spaces to achieve incident free work environment.
- Engaged in the preparation of project-related reports, manuscripts, journal articles and conference presentations.

TEACHING AND RESEACH SKILLS

- **Core teaching skills:** Course design, Lecturing/Tutoring, Classroom Management, Exam Proctoring/Grading, FERPA Certified, Mentoring, Blackboard/Brightspace Learning Management Software.
- **Core research skills:** Materials characterization**,** Alloy development, Metal casting, Heat treatment, Machining, Cold and hot rolling, Metallography, Residual stress analysis, Elemental analysis, Mechanical testing, Failure and fracture analysis, SEM, EBSD, EDS, X-ray diffraction, and 3D optical profilometry.
- **CAD design tools:** Fusion 360, SolidWorks, Ansy, Inkscape.
- **Data analytics and visualization tools**: Python, AWS, Tableau, Excel, MATLAB, and OriginLab
- **Project Management tools:** Salesforce, AWS, MS Access and agile project management

PUBLICATIONS

M. N. Issahaq, S. Chandrasekar, K. P. T., 2020, "Single-Step Shear-Based Deformation Processing of Electrical Conductor Wires," ASME J. Manuf. Sci. Eng. doi: https://doi.org/10.1115/1.4048984

M. N. Issahaq, S. Chandrasekar, K. P. T., "Multiscale Folding in Dry Cutting of Soft Commercially Pure Aluminum", (Upcoming).

M. N. Issahaq, M. Sae, S. Chandrasekar, K. P. T., "Surface Metrology of Machined Chips in Soft Aluminum Alloys", (In draft).

S. P Rodriguez, M. Sae, M. N. Issahaq, J. Mann, S. Chandrasekar, K. P. T., "Metal Strip Production by Free Machining and Hybrid Cutting Extrusion: A Demonstration, (In draft).

CONFERENCE PRESENTATIONS

The Minerals, Metals & Materials Society (TMS) Conference, San Diego, CA. **Feb. 2020.**
"Production of Commercially Pure Aluminum Strips via Single-Step, Shear-Based Techniques"

The Minerals, Metals & Materials Society (TMS) Conference, San Antonio, TX. **March 2019.**
"Surface Morphology of Commercially Pure Aluminum Electrical Conductor Wires Produced via Single-Step Machining-Based Techniques"

Materials Science & Technology (MS &T) Conference, Pittsburgh, PA. **Oct. 2017.**
"Shear-Based Processes for the Production of Strong Aluminum Electrical Conductors"

DEPARTMENTAL TALKS

Laboratory for Advanced Materials Processing (LAMP) Seminar, Purdue University.
"Large Strain Extrusion Machining for the Production of Strong Aluminum Electrical Conductors" **Sept. 2018.**

Center for Materials Processing and Tribology, Purdue University. **April 2018.**
"Stick-Slip Phenomenon in the cutting of soft metals"

Materials Engineering Department Seminar, Purdue University. **Jan. 2018**.
"Effects of Solutes on the Electrical Resistivity of Metal Alloys"

PROFESSIONAL EXPERIENCE

Data Mine Corporate Partner **Aug. 2020 to Dec. 2020**
CAT DIGITAL / PURDUE UNIVERSITY, West Lafayette, IN.

- In partnership with CAT Digital, developed a smart AI solution to reproduce thought processes in predicting equipment failures based on telematics data streams.
- Applied agile project management frameworks to plan our sprints and to deliver on the sprint objectives of the team.
- Collaborated with team members to address member problems, while productively and creatively delivering on our sprint goals.

Mine Operations Superintendent **Sep. 2014 to July 2016.**
MAXMASS LTD, Tarkwa, Western Region, Ghana.

- Supervised mining and fleet dispatch operations to achieve production targets under safe mining conditions
- Performed short- and medium-term planning of equipment schedules, reports and estimates of production volumes and overall operational effectiveness.
- Under strict guidance of production crew, achieved zero lost time injuries for two consecutive years by implementing measures such as mandatory equipment operator walkabout during night shifts.

Business Improvement Officer **Aug. 2012 to Feb. 2014.**
GOLDFIELDS GHANA LTD (GFGL), Tarkwa, Western Region, Ghana.

- Instituted continuous monitoring of drill and blast activities and quality control parameters, thus, improving blast fragmentation, powder factors and dump trucks tire life.

- Planned the schedules, monitored drill rigs performance and kept inventory of drill bits to enhance the performance and efficient use of drill machines.
- Assisted in achieving higher safety records with zero lost time injuries at the drill and blast sites for 5 consecutive months by ensuring strict adherence to the safety standards.

TRAINING AND CERTIFICATIONS

- Operations Analytics, **Jan. 2021.**
- Six Sigma Green Belt, **Jun. 2020.**
- MATLAB, **Jun. 2020.**
- Python, **May 2020.**
- Blasting Certificate of competency, Minerals Commission, Ghana **May 2015.**

LEADERSHIP AND SERVICE

Secretary, Material Science and Engineering Graduate Students Association (MSEGSA).
Purdue University, West Lafayette. IN. USA. **2018/2019**

Volunteer, MSEGSA Outreach on Materials Science / Renewable Energy
Jefferson High School, Lafayette. IN. USA. **Mar. 2019**

Volunteer, Materials Engineering Prospective Students Laboratory Tour **Apr. 2018**
Purdue University, West Lafayette. IN. USA.

Volunteer, 9th NanoDays Event, Birk Nanotechnology Center **Apr. 2018**
Purdue University, West Lafayette. IN. USA.

PROFESSIONAL AFFILIATIONS AND MEMBERSHIPS

- American Society of Mechanical Engineers, ASME
- National Society of Black Engineers, NSBE Purdue
- Minority Engineering Program, MEP Purdue.
- Association for Iron & Steel Technology, AIST
- ASM International
- Minerals, Metals & Materials Society, TMS
- American Ceramic Society, ACerS

PURDUE
UNIVERSITY

Prof. Kevin P. Trumble
School of Materials Engineering
Telephone: (765) 494-4114
driscol@purdue.edu

Black Trailblazers in Engineering Fellowship Committee
College of Engineering

18 January 2021

RE: **Recommendation for Mohammed Naziru Issahaq**

I am writing to strongly support the application of Mohammed Issahaq for a Black Trailblazers in Engineering Fellowship. I have served as Mohammed's PhD advisor over the past 4+ years. He has been very strong in research, volunteered for extra teaching duties in order to gain more experience and is loved by his fellow students for his warm, engaging, and giving personality. These are all attributes that make for success in starting an academic career in Engineering.

In research, Mohammed has been part of a large interdisciplinary group between Materials Engineering and Industrial Engineering, developing machining-based processes for directly producing metal sheet and wire in a single step of deformation. His PhD work has generated several archival research papers the first of which was just published last month. In addition to another major paper to be submitted shortly, he is a co-author on a review paper in progress. Together with conference papers/presentations, Mohammed has an excellent research record coming out.

Mohammed is a natural teacher and has genuine interest in education. Our PhD program in Materials Engineering has an integrated teaching experience requirement. In his second year Mohammed served as a teaching assistant for our large introductory Materials course, where he ran his own recitation sections, meeting with 30-35 students per section weekly for homework discussion and quizzes that he wrote. I think he discovered his passion for teaching through this experience and volunteered for a second turn last year, and is helping again as a teaching assistant this semester to launch a new graduate course in Additive Manufacturing. So, on the teaching dimension Mohammed is also well prepared and motivated for an academic career.

But perhaps most important is his personality. Mohammed is very generous with this time to help other students and pitch in whenever unexpected work comes up. He often goes out of his way to help others. This selflessness is a key ingredient also in effective mentoring of students and makes him an especially strong candidate for the academia. Overall then, for potential in research, teaching and service (engagement) he has quite a nice package.

For all these reasons I give Mohammed Issahaq my highest recommendation for a Black Trailblazers Fellowship. I think he embodies the goals and objectives of this workshop and is a top prospect for the faculty track. I'm sure he would be an inspiring teacher and mentor to future generations of students.

Sincerely,

Kevin Trumble

Kevin P. Trumble
Professor of Materials Engineering