2019 IULTCS/ERRETRE/TFL Young Leather Scientist Grant

Identification: YLSG2019_Md. Shahruk Nur-A-Tomal

COMPLETE APPLICATION FORM

□ Basic Research □ Machinery/Equipment √ **Environmental/Sustainability**

1) Applicant Information

Name	**Md. Shahruk Nur-A-Tomal**
Date of Birth	**01.01.1995**
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Phone Number	**+61 469214383**
Education (list)	**BSc in Leather Engineering** **Khulna University of Engineering & Technology, Bangladesh**
	PhD in Materials Science and Engineering **The University of New South Wales, Australia**
If student, graduating year	**2021 (Expected)**

Advisor Information

Name	**Dr Farshid Pahlevani**
Organization	**Centre for Sustainable Materials Research and Technology, School of Materials Science and Engineering, The University of New South Wales, Sydney, NSW 2052, Australia**
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By submitting this application, I commit to develop the project as outlined in the attached Research Project Plan and to complete a written report by February 28, 2019 with the following items:

1) Introduction
2) Materials and Methods
3) Results and Discussion
4) Conclusion
5) Suggestion for Future Work
6) References

Recycling tannery solid wastes and post-consumer leather products as an alternative carbon resource for steelmaking: an environmentally sustainable approach

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Introduction

The environment is facing adverse anthropogenic and natural challenges over the past several decades. Anthropogenic pollution is a worldwide problem. Industrial production and post-consumer product wastes are one of the most potentially significant environmental risks (Desenfant et al. 2004).

Tanneries are well-known to have serious negative impacts on the environment and public health. Survival of tanneries has become a great challenge. In tannery, putrescible raw animal hides/skins are converted into imputrescible leather by means of a series of chemical and mechanical operations which produce significant amounts of solid and liquid wastes as well as gaseous emissions (Covington 2009). It is reported that every ton of raw hides/skins processing converts only 200 kg of raw materials into leather and more than 600 kg is produced as solid wastes (Hashem and Nur-A-Tomal 2017). Globally, every year 6 million tonne solid waste is generated from leather processing (Masilamani et al. 2017). Moreover, considerable amounts of leather wastes are generated during manufacturing of leather products. In developing countries like Bangladesh and India, most of the solid wastes are discharged to nearby landfill sites without proper treatment which poses environmental problems (Ravindranath et al. 2015, Ahmed et al. 2017).

In addition, the disposal of post-consumer leather products, for example, footwear, garment, bag, glove, belt, watch strap, vehicle upholstery, furniture upholstery, and book-cover, etc. is a challenging issue. The global consumption of leather footwear is estimated to be 4621.2 million pairs per year and consumption in Australia is 42.6 million pairs per year (FAO 2016). Besides leather, leather products are made up with some other materials e.g. polymeric sole, foam, rexine, and textile, etc. that make it difficult to separate and reclaim completely in economically sustainable manner. The wastes are usually landfilled or incinerated which create environmental pollution.

On the other hand, over 70% of total global steel production directly depends on the inputs of coal. Globally, above 1.2 billion tons of coal is used in steelmaking (World Coal Association 2014). As the reserve of fossil fuel coal is limited that may be unavailable in the near future. Therefore, exploring alternative carbon resources to replace coal for steelmaking is urgent.

Most of the tannery solid wastes and post-consumer leather products are neither collected nor disposed of appropriately to avoid its adverse effect on the environment and human health. To date, several technologies (e.g. biological, chemical, physical, and thermal, etc.) have been developed, but there are still deficiencies in the complete management of the wastes. It is crucial to develop novel environmentally sustainable technologies that would utilise these wastes.

The characteristics of different tannery and post-consumer leather products wastes are represented in Table 1. The leather and polymeric materials could be potential resources for steelmaking.

Table 1: Carbon content and calorific value of wastes (Abajihad 2012, Bahillo et al. 2004)

Type of wastes	Carbon content (%)	Calorific value (MJ/Kg)
Raw trimmings	53.10	7.85
Fleshings	53.86	8.99
Chrome shavings	51.78	7.66
Crust trimmings	50.78	17.55
Leather trimmings	54.06	18.77
Footwear waste leather	54.90	18.95
Polyurethane foam	Not analysed	27.63
Ethylene vinyl acetate sole	Not analysed	16.57

Objectives

This study will evaluate the applicability of tannery solid wastes and post-consumer leather products in steelmaking as a source of reducing agent and heat.

Methods

The tannery solid wastes and post-consumer leather products will be collected from tanneries and/or landfill sites. The wastes will be cleaned, sun-dried, and cut into small pieces. The prepared wastes will be analysed for elements and energy content.

The wastes will be pyrolysed at different temperature in the absence of oxygen to produce char. Structural evolution of the wastes during pyrolysis will be observed. The pyrolysis process will be optimised.

The chars will be used in steelmaking (sintering, palletising, and direct reduction process) as a source of carbon and energy. Analyses will be performed to determine the level of iron reduction in steelmaking. The steelmaking process with the produced chars will be optimised.

Hypothesis/Expected Results

The chars produced from tannery solid wastes and post-consumer leather products would replace coal in steelmaking. Thus, the present attempt would i) reduce environmental pollution and also ii) make a valuable material which will cut the consumption of non-renewable fossil fuel.

Research benefit for the local or global leather industry

This research has the potential to minimize leather wastes by utilization which could abate the negative image of the leather industry in the society with respect to pollution.

References

Abajihad Z (2012) *Assessment of tannery solid waste management and characterization*, MSc thesis, Addis Ababa University, Ethiopia.

Ahmed S, Fatema-Tuj-Zohra, Khan MSH, Hashem MA (2017) Chromium from tannery waste in poultry feed: A potential cradle to transport human food chain, *Cogent Environmental Science*, 3: 1312767.

Bahillo A, Armesto L, Cabanillas A, Otero J (2004) Thermal valorization of footwear leather wastes in bubbling fluidized bed combustion, *Waste Management* 24, 935–944.

Covington AD (2009) *Tanning Chemistry: The Science of Leather*, Royal Society of Chemistry, Cambridge.

Desenfant F, Petrovský E, Rochette P (2004) Magnetic signature of industrial pollution of stream sediments and correlation with heavy metals: Case study from south France, *Water, Air, and Soil Pollution* 152, 297–312.

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Hashem MA, Nur-A-Tomal MS (2017) Valorization of tannery limed fleshings through fat extraction: an approach to utilize by-product, *Waste and Biomass Valorization* 8, 1219–1224.

Masilamani D, Srinivasan V, Ramachandran RK, Gopinath A, Madhan B, Saravanan P (2017) Sustainable packaging materials from tannery trimming solid waste: A new paradigm in wealth from waste approaches, *Journal of Cleaner Production* 164, 885–891.

Ravindranath E, Chitra K, Porselvam S, Srinivasan SV, Suthanthararajan R (2015) Green Energy from the Combined Treatment of Liquid and Solid Waste from the Tanning Industry Using an Upflow Anaerobic Sludge Blanket Reactor, *Energy & Fuels* 29, 1892–1898.

World Coal Association (2014) *Coal and Steel Statistics 2014*, London.

MD. SHAHRUK NUR-A-TOMAL

Education

2018 – Present PhD in Materials Science and Engineering, The University of New South Wales
2012 – 2016 BSc in Leather Engineering, Khulna University of Engineering & Technology

Research Interest

Solid waste management

Research Experiences

Feb 2018 – Present The University of New South Wales. Supervisor: Professor Veena Sahajwalla
Jun 2013 – Jul 2016 Khulna University of Engineering & Technology. Advisor: Dr Md. Abul Hashem

Funding

IULTCS/IUR – Young Leather Scientist Grant 2016

Selected Publications

Hashem MA, Nur-A-Tomal MS, Ahsan A, Bushra SA (2018) Hair burning liming in the tanneries: A potential sulfide source in the environment, *Sustainable Water Resources Management*.

Hashem MA, Momen MA, Hasan M, Nur-A-Tomal MS, Sheikh MHR (2018) Chromium removal from tannery wastewater using *Syzygium cumini* bark adsorbent, *International Journal of Environmental Science and Technology*.

Hashem MA, Nur-A-Tomal MS (2018) Tannery solid waste valorization through composite fabrication: A waste-to-wealth approach, *Environmental Progress & Sustainable Energy* 37, 1722–1726.

Hashem MA, Nur-A-Tomal MS, Mondal NR, Rahman MA (2017) Hair burning and liming in tanneries is a source of pollution by arsenic, lead, zinc, manganese and iron, *Environmental Chemistry Letters* 15, 501–506.

Hashem MA, Nur-A-Tomal MS (2017) Valorization of tannery limed fleshings through fat extraction: an approach to utilize by-product. *Waste and Biomass Valorization* 8, 1219–1224.

Hashem MA, Nur-A-Tomal MS, Bushra SA (2016) Oxidation-coagulation-filtration processes for the reduction of sulfide from the hair burning liming wastewater in tannery, *Journal of Cleaner Production* 127, 339–342.

Nur-A-Tomal MS, Hashem MA (2017) A novel method to preserve goat skin with indigenous plant extract to reduce salinity in the effluent. *Proc. of the XXXIV IULTCS Congress*, Chennai.

Nur-A-Tomal MS, Sharmin N, Hashem MA (2017) Fabrication of composite from dechromed leather shavings for insole. *Proc. of the XXXIV IULTCS Congress*, Chennai.

Hashem MA, Nur-A-Tomal MS, Sheikh MHR, Bushra SA (2017) Waste to wealth approach: Adhesive from the unused goat head skin. *Proc. of the XXXIV IULTCS Congress*, Chennai.

Hashem MA, Nur-A-Tomal MS, Ahsan A, Momen MA, Hasan M, Hasan A, Sheikh MHR (2017) Sulphide removal from the tannery liming wastewater by coagulation-electrocoagulation. *Proc. of the XXXIV IULTCS Congress*, Chennai.

Hashem MA, Nur-A-Tomal MS, Ahsan A (2016) Chromium removal from the tannery wastewater using indigenous adsorbent. *Proc. of the 6th International Conference on Advanced Materials and Systems*, Bucharest.

Hashem MA, Nur-A-Tomal MS (2015) One step to prepare fatliquor from the extracted fat of cowhide fleshings for using in leather processing. *Proc. of the XXXIII IULTCS Congress*, Novo Hamburgo.

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Education and Academic Qualifications

July 2017 – Present	Senior Research Fellow, SMaRT Centre, UNSW Sydney, Australia
April 2015 – June 2017	Senior Research Associate, SMaRT Centre, UNSW Sydney, Australia
July 2014 – March 2015	Visiting Fellow, SMaRT Centre, UNSW Sydney, Australia
April 2011 – June 2014	Associate Research Scientist, SIMTech, A*STAR, Singapore
April 2008 – March 2011	Research Assistant, Kitamura Laboratory, Tohoku University, Japan
Sept 2004 – March 2008	PhD and Postdoctoral Fellow, Anzai Laboratory, Tohoku University, Japan

Awards

2013	Licensing award for licensing the liquid forging, an in-house development, to AAVID THERMOALLOY Company, SIMTech, Singapore
2012	Nominated for Sawamura award and Guimaraes award for the best paper by ISIJ international journal Japan
2011	Best industrial oriented research of the year in SIMTech, Singapore
2010	Best research of the year in Iron and Steel Institute of Japan (ISIJ)
2009	Hata-no award for young researcher, Tohoku University
2007	National project for developing new method in Al casting part in Japan
2004 – 2007	Awarded Japanese government scholarship (Monbukagakusho) for my PhD

Research Funding

April 2015 – Present	1,330,000.00 Australian Dollars (Total 13 projects) I am CI or co-CI for these projects. These are from industry & government.
April 2011 – June 2014	630,000 Singapore Dollars (Total 7 projects) I was CI of these projects. These are industrial oriented research grant.
April 2008 – April 2011	100 Million Japanese Yen I was the PI at Tohoku University under supervision of Professor Kitamura.

Main Research Area

- Sustainable metal manufacturing
- Solidification and casting of materials
- Metal-Ceramic interaction at interface of metal and oxide

Patents

- Manufacturing method and products: PCT/AU2018/050390
- Surface treatment process: Provisional patent application number 2016901845
- Liquid forging: Method and apparatus for forming net-shape high-aspect ratio features No.: 13/260717
- Cup-cast method for semi-solid application: Patent No. US20090095434

Publications

More than 100 publication in peer-reviewed journal, conference and industrial reports.

28 November 2018

To Whom It May Concern:

The aim of proposed research by **Md. Shahruk Nur-A-Tomal** is to utilise the solid waste from tanneries as a source of carbon in steel making industries. This project will enable the steel industry to reduce their cost associated with traditional cokes and at the same time utilise this solid waste which is rich in renewable carbon and destined to landfill.

There is some study in utilisation of agricultural waste as a source of carbon in steel industry but utilisation of solid waste from tanneries are unprecedented yet and it very innovative project.

Upon the success of this research it can be utilised in the countries like Bangladesh or India which have a lot of tanneries and at the same time their steel industry required importing the traditional coke for their processing. This project can open a new path to utilising the locally source waste as input materials instead of imported and expensive materials. On the other hand, this project can reduce the negative effect of solid wastes from tanneries on environment by utilising them as removable carbon source.

Md. Shahruk Nur-A-Tomal has very successful experience in leather industry and at the same time during his PhD study he is familiar with steel making industry and their need to carbon source. Hence he is the best candidate for delivering this innovative and interesting project.

Yours sincerely,

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