



**INVENTORS**

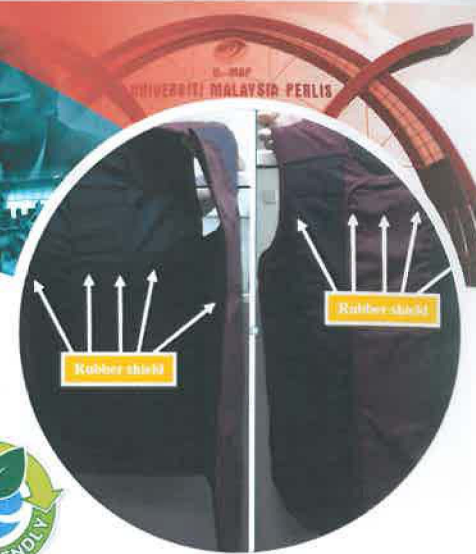
KAHAN S. MOHAMMED  
MUSTAFA AL BAKRI BIN ABDULLAH  
KAMARUDIN HUSSIN  
ALI BASHEER AZEED  
NIK NORIMAN BIN ZULKEPLI  
CHE MOHD RUZAIKI GHAZAL

**CONTACT DETAILS**

Centre of Excellence Geopolymer & Green Technology (CEGeoGTech), School of Material Engineering, Universiti Malaysia Perlis (UniMAP), P.O. Box 77, D/A Pejabat Pos Besar, Kangar, Perlis.  
Email: kahan@unimap.edu.my  
Contact No.: +6017-2884982

# ENVIRONMENT FRIENDLY ANTI-RADIATION VEST FOR PROTECTION AGAINST GAMMA RAY PHOTONS

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## INTRODUCTION

- The utilization of waste rubber powder in polymer matrices provides an attractive strategy for polymer waste disposal. In this research, lead free flexible composite material samples for anti-radiation purposes were produced, 25 wt% of recycled acrylonitrile-butadiene rubber (NBR) were added to Natural rubber (NR) to prepare the composite's matrix part
- The matrix was incorporated with various hard materials wastes such as ( iron particulates, iron fillings and slags) brought from different industry zones. The amounts of these added particulates were ranged from 15-75 wt%.
- All fabricated samples were assessed for their anti-radiation attenuation properties, the attenuation measurements were performed using gamma spectrometer of NaI (Tl) detector. The utilized radiation sources comprised <sup>137</sup>Cs and <sup>60</sup>Co radioactive elements with photon energies of 0.662 MeV for <sup>137</sup>Cs and two energy levels of 1.17 and 1.33 MeV for <sup>60</sup>Co.

## PROBLEM STATEMENT

- There are many byproduct materials of various industries represent a burden on the environment and ways to get rid of them need to waste a large amount of money, such as steel slag, iron filings, ball bearings components and other spin-offs that appear in industry.
- Development in many areas summoned the use of radioactive materials and the latter has to be preventable well because it is very harmful.
- The free-lead rubber shielding properties may vary depending on the composite constituent of the rubber blend.
- It is therefore possible to use these materials consumed by mixing with rubber for the manufacture of armor vest for protection against ionizing radiation.

## PRODUCT DESCRIPTION

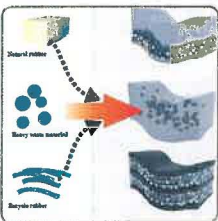
- Disposal of metal by-products from various industries, which represent a burden on the environment.
- Incorporate these consumed substances into rubber blend to produce protective shields against the threat of certain harmful radiations from different sources.
- Addition of carbon based byproducts material (slags) from steel industry to improve anti radiation performance of the rubber composites.



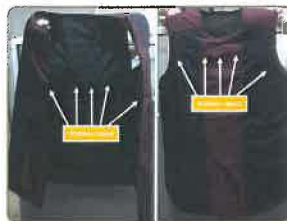
Low magnification optical graphs of the materials used in this study (a) steel slugs crushed and screened (b) iron particulates (c) the 5mm thickness NR/NBR-hard particulates samples (d) iron fillings.

## NOVELTY

- Blend of natural rubber, recycled rubber and heavy waste materials are used to fabricate green anti radiation armor vest.
- The invented material is flexible and can be arranged in the required shape that can be facility at the movement of the workers wearing this vest.



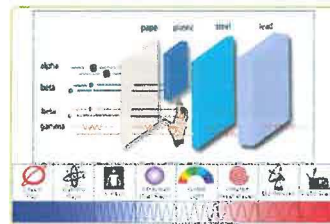
Rubber blend for radiation shielding applications



Green (Lead-free) flexible anti radiation armor vest

## TECHNICAL DATA

There are different types of radiation; it has multiple uses in a variety of fields.



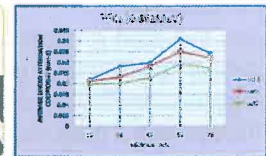
Types of radiation and shield



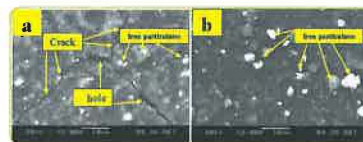
Fields of applications of radiation: Medical, security, Industrial (non Destructive Testing, sterilization of fruit and generation of electrical energy)



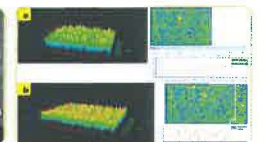
The utilization of lead in shielding



The average linear attenuation coefficient vs. mixing ratio for <sup>137</sup>Cs energy level (0.662MeV). Where Set1 iron particulates, Set2 iron filling, Set3 Steel slugs



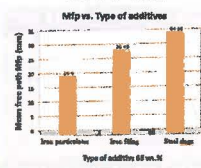
Rubber matrix with additive of iron particulates (a- 75wt.%, b-85wt.%)



Three-D surface scanning analysis for samples contain iron particulates of (a) 65 wt. %, (b) 78 wt. %.



The density for samples with metal particulate additives wt.%. Where: Set1 Iron particulates, Set2 Iron filling, Set3 Steel slugs.



Mean free path for three rubber sample contain 65wt.% from three types additive at gamma-ray energy 0.662MeV. For <sup>137</sup>Cs radioactive source

## CONCLUSIONS

The above description should suffice to show that:

- Rubber NR/NBR mixture with iron particulates can be an effective candidate as radiation protection shield as opposed to the pure lead sample currently used in radiotherapy. These fabricated samples can be used for covering walls of nuclear stores, also as protection clothing in nuclear medicine departments and nuclear investigations centers and even to prevent astronauts from cosmic radiation etc. for anti damage against gamma-ray.
- Giving the opportunity to recycle huge amounts used rubber, metal particulates and slags to be utilized to fabricate useful part instead of been sent to the landfill.
- The prepared samples are characterized to be flexible and not to break at bending.
- There is an inverse proportionality between  $\mu$  and radiation energy and direct proportionality with the samples overall density.

**PUBLICATIONS**

Basheer Azeed, Kahan S. Mohammed, Mohd Mustafa Al Bakri Abdullah, Kamarudin-Hussin, Andrei Victor Sanduand Rafiza Abdul Razak. "The Effect of Various Waste Materials' Contents on the Attenuation Level of Anti-Radiation Shielding Concrete", Materials 2013, 6, 4836-4846; doi:10.3390/ma6084836

Basheer Azeed, Kahan S. Mohammed, Andrei Victor Sanduana, Mohd Mustafa Al Bakri Abdullah, Kamarudin Hussin, Ioan Gabriel Sandu," Evaluation of Radiation Shielding Properties for Concrete with Different Aggregate Granule Sizes", REV. CHIM. (Bucharest) + 64 + No. 9 + 2013. Impact factor: 0.6

Basheer Azeed, Kahan S. Mohammed, A. M. Mustafa Al Bakri, Hana Ihsan Hasan and Omar A. Abdulkareem. "Radiation shielding characteristics of concretes incorporates different particle sizes of waste materials", Journal of Advanced Materials Research, Vol. 925 (2014) pp 190-194 . (2014). Scopus.

Basheer Azeed, Kahan S. Mohammed, A. M. Mustafa Al Bakri, and Hana Ihsan. "Radiation shielding characteristics of concretes incorporates different waste materials", Journal for Key Engineering Materials, Vol. 594-595 (2015). TransTech Publications, Switzerland. (2014) Trans Tech Publications, Switzerland.