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FOREWORD

Over the last few decades, materials are facing a continuous revolution due to significant scientific and technical achievements obtained in cutting edge areas like physics, chemistry or biology. The possibility to design the material's properties at the molecular level or to enhance their performance using advanced functionalization techniques, are making materials smart, able to respond and adapt to external stimuli, more durable and resistant and, mainly, completely adapted to each specific application.

Research and development on advanced materials for defense is being driven all over the world by the most renowned Universities, Research Centers, Military Institutes and Companies to meet important requirements to improve safety and survivability of platforms and personnel, along with requirements for enhanced maintainability and operability of platforms.

AUXDEFENSE2022 is focused on advanced materials research in the forward-looking enabling R&D domain where the intersection of key technologies in areas such as nano and microtechnology, biotechnology, meta materials, smart materials and structures, and energy generation and storage are being explored.

It is expected that AUXDEFENSE2022 may continue the work started in the previous editions (2018 and 2020), contributing for the important role played worldwide by this scientific event on the integration of the whole set of agents involved on this topic, bringing together scientists, researchers, militaries, students, technicians, entrepreneurs, end-users, companies, among others.

AUXDEFENSE2022 is the meeting point for all those interested on advanced materials for application in the defense field, including about 100 presentations from representatives of 35 countries, from 5 continents.

Guimarães/Portugal, 6 July 2022

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Conference Chairman

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BALLISTIC IMPACT OF UHMWPE-GLASS-AUXETIC MULTI-LAYER SANDWICH PANELS, TO THE LEVEL III OF NIJ 0108.01

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AUXETIC MATERIALS AND STRUCTURES FOR POTENTIAL DEFENSE APPLICATIONS

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ABSTRACT

An auxetic material exhibits exceptional features compared to conventional material. It gets broadened when it is stretched or becomes smaller when it is compressed because it has a negative Poisson's ratio. Moreover, auxetic materials possess some enhanced properties, such as shear resistance, indentation resistance, fracture toughness, energy absorption, etc. These enhanced properties make the auxetic materials very attractive for many potential applications. This paper reviews the latest advances in research work in structures, mechanical properties, the manufacturing methods of auxetic materials used for defense applications, including armor systems. The results obtained here serve as additional guidelines to assist engineers and designers in the use of auxetic materials for military personnel protective clothing.

INTRODUCTION

Auxetic materials and structures, which produced based on woven structures, knitted structures, nonwoven structures, and braided structures (Alderson et al., 2005; Hu et al., 2019), can exhibit a negative Poisson's ratio (NPR) (Boakye et al., 2019; Wang & Hu, 2014). Each auxetic structure can exhibit different deformation mechanisms and auxetic performance (Evans, 1991; Hu et al., 2019). Therefore, military personnel protective clothing including jackets, shirts, pants, helmets, boots, gloves, and even body armor is a necessity. A special material that is used to fabricate armour system must absorb energy locally and be able to spread the energy out fast and efficiently is necessary for protection purposes. This article comprehensively demonstrates an organizational integration of (i) mechanical properties of auxetic materials and structures (Boakye et al., 2019; Chan & Evans, 1999; Francisco et al., 2021; Hu et al., 2019; Jiang et al., 2022; Li et al., 2020; Liu, 2006; Luo et al., 2021; Scarpa et al., 2006; Steffens et al., 2016; Wang & Hu, 2014), (ii) manufacturing methods (Hu et al., 2019; Jiang et al., 2022; Liu, 2006; Underhill, 2014) and (iii) potential applications in defense (Hu et al., 2019; Jiang et al., 2022; Steffens et al., 2017; Steffens et al., 2016).

RESULTS AND CONCLUSIONS

Some auxetic materials and structures, mechanical properties, manufacturing methods, and potential defense applications are covered in this report. This is the premise for our further studies in the design and production of auxetic materials for protective clothing.

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