

Name: Mana Alyami Team

Number:18F17 Team Name:

Smart Helmet Individual

Analysis: viscoelasticity

Section:001

Introduction D3O is an impressive material which can be used in anything to make it more efficient in its shock absorbing capabilities. Moreover, the impressive design of the D3O at the molecular level makes it an extra ordinary invention as it molecules contract making it more strong to resist impulsive forces and as the molecules of D3O compress in a designed manner, the resultant of impulsive force is reduced as the shock is absorbed by the material.

This interesting technology can be of vital use in many aspects of life. It can be efficiently used in a wide variety of products such as footwear, electronics, military gears and helmets. With an enhanced capability of shock absorbing capability, the design of life saving products such as helmets can be made more efficient and there are more chances that severe accidents can be saved by the use of D3O in the helmets.

When it comes to shock absorbing materials, the choice of materials is very brief as the cost effectiveness of the material and the shock absorbing capability is directly related to each other. Moreover, shock absorbing materials use various mechanism which cannot withstand large impulsive forces and the chances of failure of such materials even after being expensive are high which is the issue being faced in the industry at the present day.

With the usage of D3O impact protection shock absorbing material, the shock absorbing capability of the products by the usage of this material can not only be increased to an optimum level, but its response to the large impulsive forces is also quite impressive as the mechanism its designed for at the molecular level makes it even more stronger when an impulsive force is applied on it. Following picture depicts the shock absorbing mechanism of D3O impact protection shock absorbing material:

Working Mechanism of D3O D3O materials behave as normal material when free

from any influence of force but when an impulsive external force is applied, the molecules of the material are locked together and absorb the energy imparted by the external impulsive force while it also makes the material more stronger as the molecules are locked and the stress bearing capacity of the material is enhanced. Following image depicts the working of D3O material and why it is used in the life saving products such as helmets and military gear:

Factors Enhancing the Shock Absorbing Capability of D3O There are numerous factors according to the design and shock absorbing capability of D3O which makes this an optimum material and chosen for the production of helmets using this material. The main factor which makes the shock absorbing capacity of D3O more efficient is the behavior of molecules on the application of force. When the force is applied, the molecules of the material follow non-Newtonian behavior and lock together which not only absorbs the force but also results in increasing the strength of the material. Not only this, the cost effectiveness of this material also makes this material more optimal for the use. The 3-layer design not only increases the durability of the material but also results in decreasing the impact of impulsive force and transmits only a small portion of the force.

Mathematical Equation for Material The material follows the Prony series approach for viscoelasticity which determines the behavior not only for the relaxed state of material but also when force acts on it. Following equation determines the behavior of material:

$$\sigma(t) = G_{\infty} + (G_0 - G_{\infty}) [1 - e^{-t/\tau}]$$

Where G_0 is the shear modulus obtained from data which is independent of the relaxation data and creep experiment is performed to obtain the shear modulus.

Project Diagram The molecules of the material move freely under the influence of no force but when an external force is applied on the layer 1, the molecules of the material in the layer 2 are locked and compressed following the equation mentioned above, which results in transmitting a very less amount of force in the third layer and makes the material even more stronger as the molecules in the shock absorbing layer are concentrated.

Results As a result of using this material in the helmets, military gear and footwear, the shock absorbing capabilities of the products can be increased to an optimum level keeping the cost effectiveness of the material under consideration As this material is cost effective as well as durable, it can also be used in daily life products which not only increases the durability of the products in which D3O material is used but also results in increasing the shock absorbing capability of the products in which it is utilized.

Reference

S

[1] D. Labs, "D3O Materials," D3O, January 2018. [Online]. Available: <https://www.d3o.com/what-is-d3o/materials/>. [Accessed November 2018].

[2] J. Hauer, "Prony's method," Wikipedia, March 2017. [Online]. Available: https://en.wikipedia.org/wiki/Prony%27s_method. [Accessed November 2018].