DREADNOUGHT™
TECHNOLOGIES

PRODUCT & TECHNOLOGY ABSTRACT

Vibration and noise reduction in a large range of structures – from boring tools to ships – has been an active area of research for more than twenty years.[1,2] One successful strategy for reducing vibration and noise is to utilize a laminate shell structure consisting of a soft, viscoelastic material between two structural, hard elastic layers.[3] Known as constrained-layer damping (CLD), these composite structures have a proven track record of reducing vibrations in automotive and aeronautic applications.[4] Prior research has shown these structures to be effective in damping vibrations under dynamic loads in high-energy laser applications, thus reducing unstable, flow-induced vibrations in laser cavities.[5] CLD structures have also been proven effective in dissipating the vibrations induced under impulse loading, such as a shockwave applied to the material.[6]

These same structures show enhanced stability and thermal dissipation in boring bar tools and improve the conversion of mechanical energy into heat.[7] The CLD structures reduce the noise inherent in the application, decrease the overall weight of the structure, and subsequently increase the structure's lifecycle and level of reliability.[8]

Viscoelastic materials use hysteresis to convert vibrations into heat. The elastic properties return the material to its original position when deformed. The viscous fluids slowly stretches when stressed, opposing the stressing force. The degree to which a

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[1]L. Daghini, A. Archenti, and C.M. Nicolescu, "Design, Implementation and Analysis of Composite Material Dampers for Turning Operations," *World Academy of Science, Engineering and Technology*, vol. 53, 613-620, (2009).
[2]V.O.S. Olunloyo, C.A. Osheku, and F. Agboola, "Vibration damping and active noise control in ships and floating structures," 26th International Conference on Offshore Mechanics and Arctic Engineering, June 10-15, 2007, San Diego, CA.
[3]B. Kovacs, "Transverse Shear and Normal Deformation Theory for Vibration Analysis of Curved Bands," *Journal of Computational and Applied Mechanics*, 5, 49-64, (2004).
[4]M.D. Rao, "Recent applications of viscoelastic damping for noise control in automobiles and commercial airplanes," *Journal of Sound and Vibration*, vol. 262, 457–474, (2003).
[5]C.D. Johnson and D.A. Kienholz, "Prediction of Damping in Structures with Viscoelastic Materials," presented at the 1983 MSC/NASTRAN Users' Conference, March 24-25, 1983, Los Angeles, CA.
[6]V.F. Nesterenko, "Shock (Blast) Mitigation by 'Soft' Condensed Matter," MRS Symp. Proc., vol. 759, pp. MM4.3.1- 4.3.12, (MRS, Pittsburgh, PA, 2003).
[7]Daghini.
[8]Y.P. Lu and G.C. Everstine, "More on Finite Element Modeling of Damped Composite Systems," *Journal of Sound and Vibration,* vol. 69, 199-205, (1980).

material behaves elastically or as a viscous fluid depends on the temperature and the frequency of vibrations.[9] Viscoelastic materials are effective at damping vibrations in a transitional regime when the material loses its dynamic stiffness and begins to act like rubber material. In CLD structures, the viscoelastic material deforms in shear due to the stiff outer layer. This causes the vibrating energy to dissipate as heat in the shearing mode within the viscoelastic layer.[10] A CLD structure – applied to a weapon – reduces noise and vibrations through the viscoelastic damping of the impulse-generated vibrations in the weapon's barrel. Figure 1 illustrates a sample construction of a CLD structure applied to a rifle barrel. The shockwave traveling down the barrel couples mechanical energy into the viscoelastic-damping layer, which then dissipates this energy thermally. Dreadnought Technologies LLC calls this construction Dreadnought™ technology.

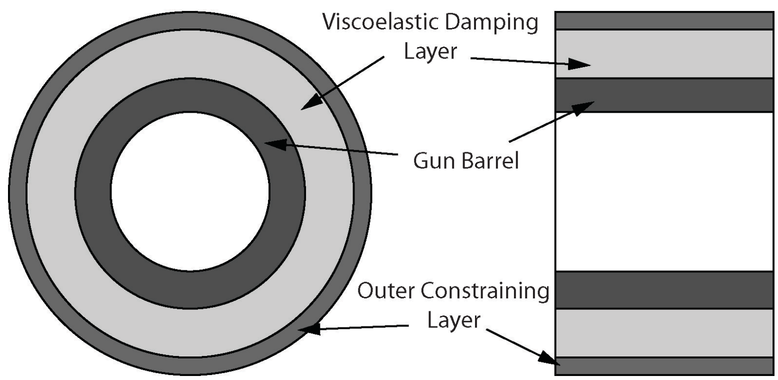

Figure 1: Constrained-layer damping barrel configuration shown in axial and cross-sectional views.

[9] Rao.
[10] Rao.