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STRUCTURAL HEALTH MONITORING OF GLASS FIBER USING PIEZO MATERIAL

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ABSTRACT

Investigating a new generation of structural health monitoring (SHM) system of glass fiber in which a piezo material is embedded into it. It is excited by placing the piezo material at different points inside the glass fiber composite and investigated. Further various applications in the aerospace industry and as a source of electricity are investigated.

KEYWORDS: *Structural Health Monitoring*

INTRODUCTION

With the rapid innovation in the field of microelectronics, electronic devices which are used in day-to-day life are shrinking. Moreover, their power requirements are shrinking too. Therefore, more portable power sources need to be prepared, rather than using conventional power sources such as batteries, such that the power sources could be accessible from any corner of the world. Electrostatic, electromagnetic and piezoelectric are basic common mechanisms used for energy scavenging applications.

In Energy harvesting, Piezoelectricity has shown great results. Piezoelectric materials are source of anthropogenic energy harvesting which yields good energy density, high electro mechanical conversion efficiency and they are easily drawn into sheets, films and other flexible structures that can be easily result into body wear. Quartz, Rochelle salt, etc. are Naturally occurring materials which exhibit Piezo electricity properties. Ceramics like lead zirconate titanate (PZT), polymers like polyvinylidene fluoride (PVDF) are some Manmade materials which exhibits piezo electricity properties.

Change in the shape of these materials results in response to application of electric current. Piezo materials are so adaptive that they find applications in various equipment's like in telephone buzzers, gas lighter, ultrasonic cleaners and missiles. They are applied in a wide range of equipment's, ranging from household equipment's to industrial equipment's. As the demand for electronic devices is increasing rapidly, energy and biomedical industries researchers are continuously trying to explore new materials and device configurations for new applications. Also, engineers are constantly making continuous effort to improve the existing technologies and invent new technologies. As the realm of the piezo electric materials is vast, it is mandatory to provide an overview on individual branches of piezo electric materials. We believe that our effort will give an additional information on the current research and development status of piezo electric material community. Additionally, we expect that this issue could create new ideas for advanced future applications.

In the aerospace industry, the piezo electric materials can be used in Structural health Monitoring (SHM) where the unification of mechanical structures is checked while it is in use, Micro-thrusters for satellites, Active vibration Damping in mechanical structures, Piezo electricigniters, generating voltage, store charge and drive microelectronics directly because of its ability to sense, actuate and harvest energy.

STRUCTURAL HEALTH MONITORING

Piezo electric materials are used in structural health monitoring (SHM), where the cohesion of mechanical structures is checked. SHM is salient where safety is a main issue e.g., infrastructure and building structures, aerospace structures, transport structures. The continuous checking advantages financially which results in early analysis of the materials and can be repaired rather than completely changing it. Structural Health monitoring is used in various industries and has various important applications with its advanced technologies. For the application of piezoelectric material, this review has reported with some methodologies used to perform SHM on a damaged structure for analysis and improvement. The intensification of orthotropic and isotropic material with piezo material can improve its properties. The stiffness and structural strength of the material together make it an effective material.

Delamination in the structures plays a vital role in reducing rigidity and structural strength, reducing device cohesion and reliability so that the lamb-wave technique can be efficiently applied using piezoelectric material embedded within a composite plate for structural health monitoring. SHM is built from non-destructive testing (NDT), blends advanced sensor technologies with cognitive algorithms to examine systemic structural health conditions. Statistic model creation is concerned with the execution of algorithms that use the extricate features to measure the extent of the damaged structure. Several researchers are focusing on SHM techniques based on guided wave propagation for the identification of minor emerging vulnerabilities in engineering systems. Defects, which are often not visible to the naked eye keep on worsening until it is predicted and fixed. Guided wave propagation techniques for SHM are mostly used in the aerospace industry instead of using traditional non-destructive methods, because it can detect very small losses. Guided waves are actively used in area of study in SHM for aerospace, as demanded by aerospace industry. Delamination studies identify stiffener debonding and delamination cracks suitable for composite structures. Piezoelectric materials have both the mechanical properties and electrical properties which are used in the field of SHM engineering.

PIONEERING WORK

A PZT (lead zirconate titanate) layer is taken, and it is embedded into Glass fiber Reinforced polymer at different distances from the end point. Firstly, the PZT layer is embedded at 1/8 the distance from the end of the GFRP layer and it is exited and checked for the electricity produced. Accordingly, the PZT layer is placed at different distances from the end point of GFRP i.e., it was placed at 1/6, 1/4,1/3 and 1/2, the distance from both the ends and it was excited. It was seen that it produced the highest electric voltage of 12V, when the PZT layer was placed at the middle i.e., 1/2 the distance from the end.

When it was excited, the Environmental excitation energy got transformed into Mechanical vibration energy and further it got transformed into Electrical energy output. The electric voltage which was produced can be used in various industries and in various equipment’s used in day-to-day life.

CONCLUSION

From the above experiment done by embedding the piezo material layer (PZT)in the Glass fiber Reinforced polymer, it was found out that when it was excited, it generated an electronic voltage. Additionally, the highest electronic Voltage received was 12V, when the PZT layer was embedded at the center of the Glass fiber Reinforced polymer. Composite piezoelectric materials have shown good competence as an alternate source of electrical power source, capable of generating enough energy to power microelectronic devices. Attempts were previously made to find out the best position to place the piezo material inside a Glass fiber Reinforced polymer, so that the maximum Electrical energy output is achieved. Although our preliminary experiments have not yielded significant results, we intend to further refine complications and limitations involved in the usage in day-to-day life.

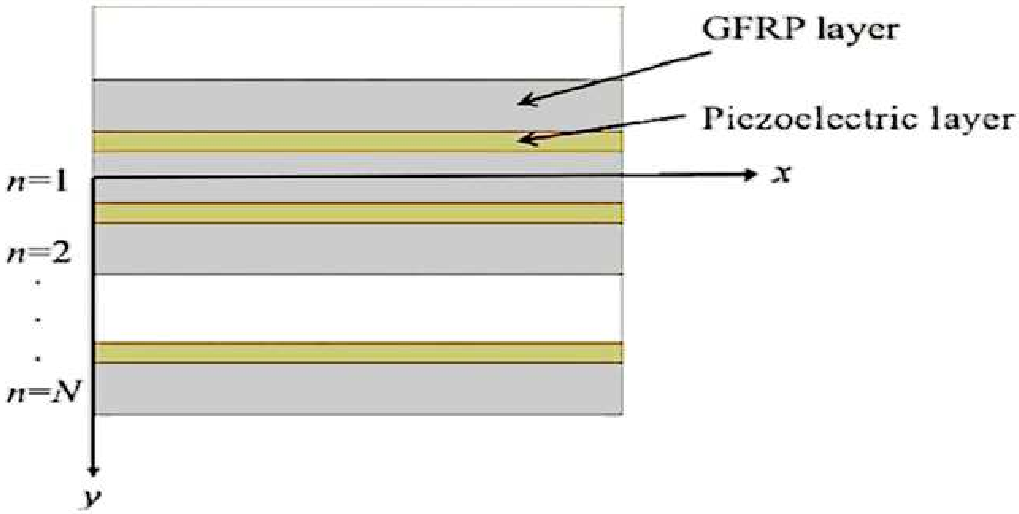

Figure 1

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