# Investigation of mechanical properties of nanoparticle reinforced carbon and basalt composites

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## Abstract

**Statement of the problem:** The structure and type of reinforcement element used in composites are crucial for achieving the desired mechanical properties. Woven fabrics obtained from high-performance fibers are the most commonly used reinforcement elements. Additionally, the use of nanoparticles can enhance the performance of these reinforcement elements to achieve high-performance composites. The effect of the variation in woven fabric structure and material, along with the type of nanoparticle used, has become an important subject of investigation. The aim of this study is to determine the mechanical properties of composites made by combining carbon and basalt fabrics with resin systems and to examine the effect of fabric areal weight on these properties. $SiO_2$ nanoparticle was also used as a reinforcement to improve the mechanical properties, and the changes in the mechanical properties of composites made from basalt and carbon fabrics were examined. Composites made from carbon and basalt fabrics were compared in terms of cost, strength, and areas of use. The behavior of $SiO_2$ nanoparticle with fabric type and fiber type was interpreted based on the mechanical properties. Raw materials used in the industry are generally petroleum-based products, and their production consumes a lot of energy and releases harmful by-products, causing environmental damage. The increasing awareness of energy and environmental issues in the evolving world has led to an increased demand for more environmentally friendly and cost-effective materials. Especially, the high energy consumption and the releasing of harmful gases such as $CO_2$ in the production of carbon fibers have increased the need for reinforcement elements that are high-strength but more environmentally friendly. In this regard, we can say that basalt fiber has entered the scene. The fact that basalt fiber production consumes less energy than carbon fiber production and releases less $CO_2$ makes it preferable.

In this study, plain pattern 200 g/m² and 245 g/m² carbon woven fabrics were used as carbon reinforcement fabrics. Plain pattern 200 g/m² basalt woven fabrics were used as basalt reinforcement fabrics. Silicon dioxide was used as the nanoparticle, and epoxy resin was used as the matrix material. The composite parts produced by the vacuum infusion method were then subjected to mechanical tests.

In composites made from carbon fabrics without $SiO_2$, an increase in areal weight reduced tensile strength while increasing flexural strength and impact resistance. This effect was observed due to the increase in weave count.

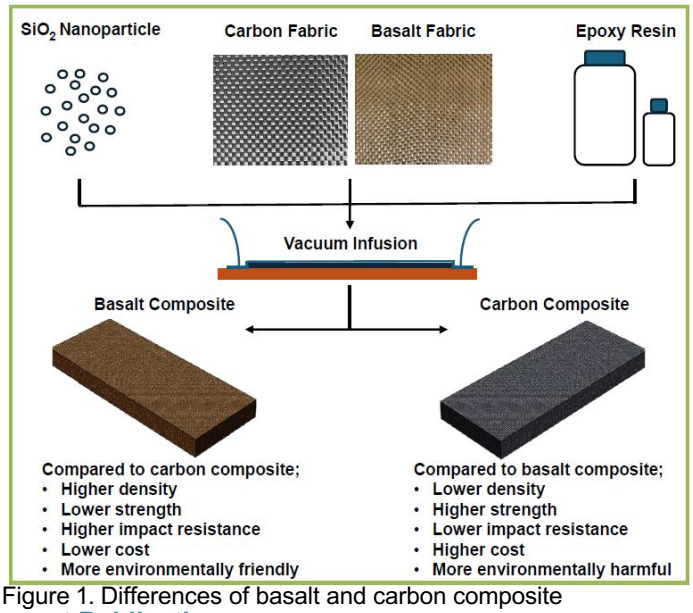


Figure 1. Differences of basalt and carbon composite

## Recent Publications:

1. Güner A.T., Meran C., Biomaterials used in orthopedic implants, Pamukkale University Journal of Engineering Sciences, 26(1), 54-67, 2020 (in Turkish).
2. Korkmaz E., Meran C., Gas metal arc welding of XPF800 steel for automotive industry: Microstructural evaluation and mechanical properties investigation, Proceedings of the Institution of Mechanical Engineers, Part L: Journal of Materials: Desing and Applications, 236(4), 747-756, 2022.
3. Korkmaz, E., Meran, C, Mechanical properties and microstructure characterization of GTAW of micro-alloyed hot rolled ferritic XPF800 steel, Engineering Science and Technology, an International Journal, 24 (2021) 503–513, https://doi.org/10.1016/j.jestch.2020.04.00

## Photograph

## Biography

Prof. Dr. Cemal Meran was born on April 03, 1972. He holds undergraduate degrees in Mechanical Engineering in 1993. He obtained a PhD in Mechanical Engineering in the Turkey at Pamukkale University (2001). In April 2013 he was promoted to Professor of Department of Mechanical Engineering. He also carries administrative responsibility including, Manager of Center of Materials Research and Application since 2009. His areas of interest are joining methods, welding metallurgy, production methods, materials science and characterization of the joints. Professor Meran's current research can be broadly classified as friction stir welding of similar or dissimilar metals. Focus is on friction stir welding of especially elevated temperature metals such as steels or stainless steels, etc.He was deserved honorary awards of the Prof. Fryderyk Staub Golden Owl in 2012 for achievements in promoting the Polish science and higher education on the international arena and for achievements in collaboration with the Polish scientific community of materials engineering. He is member of Editorial Key Reviewers Committee of some international journals such as Journal of Achievements in Materials and Manufacturing Engineering, Archives of Materials Science and Engineering, Archives of Computational Materials Science and Surface Engineering, some Turkish Journal Materials and Metallurgy, Engineers and Machine. He was chair of alumni association of Pamukkale University from 2002 to 2005.He has married, and has got two child..

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Batuhan Şenkaya began his university education at the Department of Mechanical Engineering, Faculty of Engineering, Pamukkale University in 2016 and graduated in 2021. He started his master's degree at Pamukkale University in 2021 and is currently continuing his education.

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