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Research Article

Investigation of UV aging influence on low velocity impact behavior of interply hybrid composites

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ABSTRACT

This study investigates the effects of UV aging on the low-velocity impact behavior of hybrid and non-hybrid polymer composites, focusing on configurations using glass and aramid fibers. Composite samples were exposed to UV radiation for 0, 450, and 900 hours, and their impact properties were measured through flatwise and notchwise Charpy impact tests. Results showed significant degradation after 450 hours, with the glass/epoxy composite (P1) exhibiting a 35.37% reduction in flatwise impact strength from 65.77 kJ/m² to 42.51 kJ/m². Hybrid composites, such as the glass-aramid-glass configuration (H1), demonstrated improved resilience, with a smaller 29% decrease to 77.04 kJ/m². After 900 hours of exposure, all configurations showed partial recovery in impact properties, attributed to possible matrix reorganization; however, the overall impact strength remained lower than in non-aged samples. For instance, flatwise impact strength in P1 was reduced by 17.87% compared to control, while H1 and H2 hybrids experienced 17.07% and 21.75% reductions, respectively. These findings underscore that hybridization, especially with aramid, enhances resistance to UV-induced degradation, suggesting hybrid composites as superior candidates for applications in UV-intensive environments.

1. Introduction

Polymer based composite materials are preferred in engineering studies and research for several key reasons, primarily due to their superior properties and performance advantages over traditional materials like metals or pure polymers. Composites, especially those made from carbon, glass, aramid offer high strength while being much lighter than metals like steel or aluminum. This makes them ideal for aerospace, automotive, and marine applications where weight reduction is crucial for efficiency. Despite being lightweight, composites can offer excellent mechanical strength, often outperforming traditional materials in specific applications [1].

Unlike metals, composites can be engineered to provide strength and stiffness in particular directions, based on how the fibers are oriented. This allows optimization of performance in areas of high stress. One of the most convenient ways to do this is to hybridize different fabric types with different arrangements, such as layer-by-layer or interlayer [2-4]. Hybridization in composite materials refers to the combination of two or more different types of fibers (e.g., glass, carbon, aramid) or matrices within a single composite structure. The purpose of this approach is to capitalize on the distinct advantages of each material, creating a composite that offers a balanced combination of properties that no single material could provide on its own. Hybrid composites are designed to meet specific engineering requirements more effectively than traditional composites [5]. Furthermore, hybridization can enhance the material's ability to absorb energy during impact (e.g., by including tough fibers like aramid), while still maintaining high tensile strength and stiffness from fibers like carbon or glass.

Composites, especially hybrid ones (combining materials like glass and aramid fibers), can offer better impact resistance than metals in certain configurations, which is important for safety-critical applications like automotive crash structures or protective gear. Impact testing is crucial in composite materials for several reasons, as it helps determine the material's behavior under sudden loads or forces. These insights are critical for

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ensuring the reliability, safety, and performance of composite structures in real-world applications. Impact resistance is a measure of how well a material can absorb energy and resist damage when subjected to a sudden force [6,7]. Composite materials, especially in industries like aerospace, automotive, and sports, are often exposed to impact forces (e.g., crashes, collisions, falling objects). Impact testing provides essential data on how well the material can handle these conditions without suffering catastrophic failure. Impact testing is used to compare how composite materials perform under different conditions, such as varying temperatures, environmental exposure (e.g., UV aging, moisture), and different fiber arrangements or hybrid combinations. This is especially important in determining how composites will react to impacts in different environments or after long-term exposure to elements that could degrade the material. Environmental conditioning is critical for composite materials because they are often exposed to various environmental factors-such as temperature fluctuations, humidity, UV radiation, and chemical exposure-that can significantly affect their performance, durability, and long-term reliability. These factors can degrade the mechanical and physical properties of composites, influencing their behavior in real-world applications. Understanding how composites respond to environmental conditions is essential for accurate material selection, design, and maintenance [8-11].

Fiore et al. [12] evaluated the aging resistance of jute-basalt hybrid composites, which are proposed as novel multilayer structures for cladding. The study compares the aging performance of jute-reinforced laminates with two different hybrid laminates, which use a combination of jute and basalt fibers arranged in different stacking configurations (sandwich and intercalated). The composites were subjected to accelerated aging cycles involving hygrothermal stress and UV radiation over 84 days. Samples were tested after 14, 28, 56, and 84 days. Mechanical tests, including flexural tests, impact tests, and dynamic mechanical analysis (DMA), were performed on the aged and unaged samples to evaluate their mechanical behavior and aging resistance. The results showed that the hybrid laminates (both sandwich and intercalated) exhibited better impact energy absorption and flexural properties than the jute-only laminates. The sandwich configuration showed superior aging resistance due to the barrier effect of the outer basalt layers, which protected the internal jute layers from degradation. Post-curing reactions in the early aging stages enhanced the matrix stiffness and improved fiber-matrix adhesion, but long-term exposure led to degradation from UV radiation and moisture, reducing mechanical properties over time.

Mayandi et al. [13] investigated the durability and degradation of fiber-reinforced polymer (FRP) hybrid composites when exposed to different environmental conditions (thermal aging, hydrothermal conditions, UV radiation, seawater, and acidic environments). It was found that elevated temperatures and moisture exposure lead to rapid degradation, reducing strength and stiffness. Further, UV exposure causes surface degradation, resulting in matrix cracking and fiber weakening. The researchers reported that UV exposure results in surface cracking, discoloration, and embrittlement of the polymer matrix. This degradation weakens the interfacial bonding between fibers and the matrix, leading to a reduction in mechanical performance, especially in terms of impact resistance. Also, it was observed that The UV radiation causes cracks in the matrix, reducing the durability and strength of the composites.

Silva et al., [14] researched the impact properties of curaua/aramid hybrid composites under UV B radiation. Samples were exposed to UV-B radiation for 300 and 600 hours. The effects of UV radiation led to changes in the macromolecular structure of curaua fibers. UV exposure increased the degree of cross-linking in the polyester matrix, resulting in a stiffer material but reduced its capacity to absorb impact energy. The ballistic performance decreased after UV exposure; however, samples exposed for 600 hours performed better than those exposed for 300 hours. Ballistic tests showed that absorbed energy was approximately 14% lower in UV-exposed samples compared to non-irradiated ones

Gualberto et al. [15] researched the ultraviolet radiation impact on the mechanical behavior of glass fiber reinforced polymers (GFRP). GFRP subjected to UV radiation for up to 180 days and expose to test at the end of each 30-day period. It was reported from results that the tensile strength of the composites decreased by 3.4% after 30 days and by 18.7% after 90 days of UV exposure. However, an improvement in strength was observed after 120 days, likely due to post-curing effects from elevated temperatures. When bending test results are examined it was found that an initial increase in flexural strength of 54.1% was noted after 30 days. However, starting from 60 days, a decrease in strength began, with the strength remaining 18.9% higher than the unaged composite after 180 days.

Nicholas et al. [16] examined the effects of accelerated environmental aging on glass fiber-reinforced thermoset polyurethane composites, specifically focusing on microstructure and impact behavior. The researchers used a combination of hygrothermal and UV exposure to simulate environmental conditions and conducted tests at intervals of 250, 500, 750, and 1000 hours. It was found that no significant change in the bulk impact properties of the composites. The materials demonstrated strong resistance to environmental aging, with only minimal variation (less than 10%) in maximum load and absorbed energy across different impact energies (10 J, 20 J, and 30 J). Further, researchers revealed that the accelerated environmental aging caused surface-level deterioration, particularly in color and fiber exposure. However, the bulk mechanical properties, such as impact resistance, remained largely unaffected due to the protective effect of the glass fiber reinforcement.

Uddin et al. [17] investigated the effects of UV light and moisture on the low-velocity impact resistance of three different carbon fiber-reinforced composites: unidirectional, plain weave woven, and non-crimp fiber (NCF) laminates. At the end of study, it was reported that after UV and moisture exposure, all laminates showed a decrease in impact performance, but NCF laminates showed the least degradation compared to unidirectional and woven laminates. The results showed that the absorbed energy by the unidirectional laminate, woven laminate, NCF-symmetric laminate and NCF-a symmetric laminate reduced 20.98, 17.7, 1.06 and 1.39% respectively, after UV aging.

Barvarz et al. [18] assessed the mechanical, water absorption, and aging properties of polypropylene (PP) hybrid composites reinforced with flax and glass fibers. The aim was to assess the impact of glass fiber hybridization on the performance of these composites, focusing on water, thermal, and UV aging. It was revealed that Glass fibers accelerated the UV degradation of PP, with G40 (40 volume% glass) showing a 56% reduction in tensile strength after 400 hours of UV exposure. Conversely, flax fibers provided UV protection due to the lignin content, which absorbs UV radiation, leading to less degradation.

This study is important and original in its focus on the effects of UV aging on hybrid composites, specifically glass-aramid configurations, under impact conditions-a topic that has seen limited exploration in the existing literature. While previous research has addressed the impact resistance of various fiber-reinforced composites and the degradation effects of environmental exposure, few studies provide a comprehensive comparison between hybrid and non-hybrid configurations under prolonged UV exposure. Additionally, this research uniquely employs both flatwise and notchwise Charpy impact tests, offering a dual approach to evaluating impact performance under different orientations. By examining the differences in impact strength and energy absorption over extended UV aging periods (450 and 900 hours), the study reveals crucial insights into the long-term durability and mechanical resilience of hybrid composites. Unlike earlier work, this investigation also highlights the specific structural advantages of layered glass-aramid configurations, which are shown to enhance impact resistance and UV stability compared to pure composites. These findings contribute novel information to the field, supporting the development of more resilient composite materials for UV-intensive environments, such as aerospace and automotive applications, where material integrity under prolonged environmental stress is critical.

2. Materials and Procedures

2.1 Materials

For this study, woven glass and aramid fabrics with densities of 202 and 170 g/m^2 and fabric thicknesses of 0.15 and 0.27 mm, respectively, were used. Additionally, MGS 285 series epoxy and hardener were used as the resin system. All materials were sourced from Dostkimya Company in Istanbul. Representations of aramid and glass fabrics are depicted in Figure 1 a) and b), respectively.

2.2 Manufacturing Process

The hand lay-up method was used to create composite plates at the ambient temperature of 25°C. All of the fabrics, hardener, and epoxy were provided by the Dostkimya Company in Istanbul. Hexion MGS-L285 epoxy and Hexion MGS-H285 hardener were combined in a 100:40 ratio. Epoxy resin and hardener were combined using a mechanical stirrer set at 8000 rpm for 10 minutes. For this study, composite plates were produced in four configurations, two of which were pure and two were hybrid with the sandwich model. The group consisting of 12 glass fabrics was named P1, and the group consisting of 12 aramid fabrics was named P2. In addition, the hybrid model created with three glass fabrics outside and six aramid fabrics inside was named H1, and the hybrid model created with three aramid fabrics outside and six glass fabrics inside was named H2. All layers are stacked in 0-90° orientation angles. The samples were cured for an hour at 80°C using a hot mold press (Figure 2 a)) fitted with flat molds and pressurized to 0.4 MPa. The laminates were not finished until they were at room temperature. Figure 2 b) shows a flow chart for a production process. The thickness of the samples is given in Table 1.

2.3 Accelerated UV Aging

In this study, accelerated UV testing was performed using OSRAM brand ultraviolet lamp in accordance with the relevant ASTM standard [19].

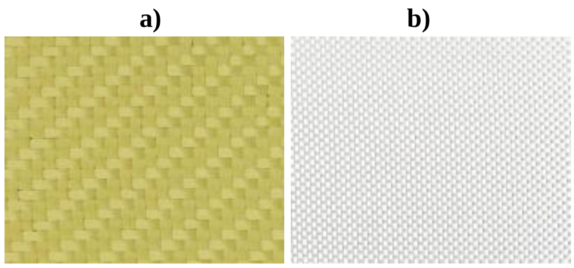


Figure 1. a) Aramid fabric b) Glass fabric

a)

b)

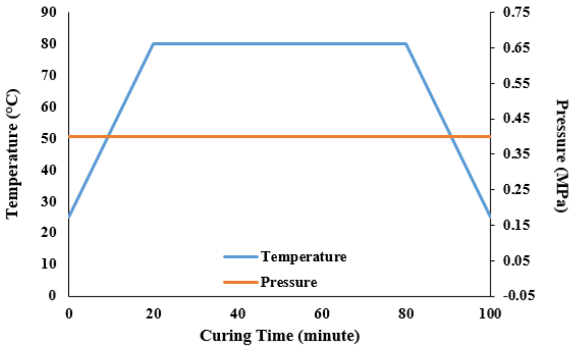


Figure 2. a) Hot mold press machine b) Production process

Table 1. Thickness of samples

Thickness (mm)			
P1	**H1**	**H2**	**P2**
2.41±0.03	2.45±0.02	2.82±0.05	2.91±0.07

Three groups of composite materials were produced for each configuration. One part of these was the control group (not exposed to UV aging), the other part was subjected to 450 hours of UV aging and the other part was subjected to 900 hours of UV aging. Five samples were tested for each group.

2.4 Low Velocity Charpy Impact Test

The 55 mm by 10 mm Charpy impact test specimens were created and examined in accordance with ISO 179/92 standards. The Charpy impact tests were performed on flatwise samples and edgewise samples using a pendulum impact machine with 15 J (Köger 3/70 Germany) (Figure 2). Equations (1) and (2) were used to compute the energy that was absorbed and impact toughness values, which were as follows:

$$E = E_i - E_f \quad (1)$$

$$K = \frac{E}{h \, x \, b} \quad (2)$$

Where E, E_i and E_f are the absorbed energy, initial energy and final energy, respectively. In addition, K, h and b symbolize toughness, sample thickness and width of the sample, respectively. The schematic illustration of flatwise and notchwise Charpy impact test is shown in Figure 3 a) and b), respectively.

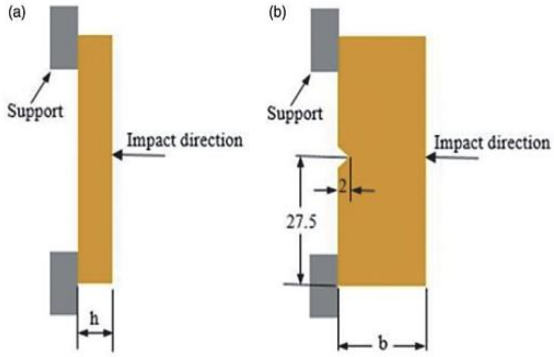


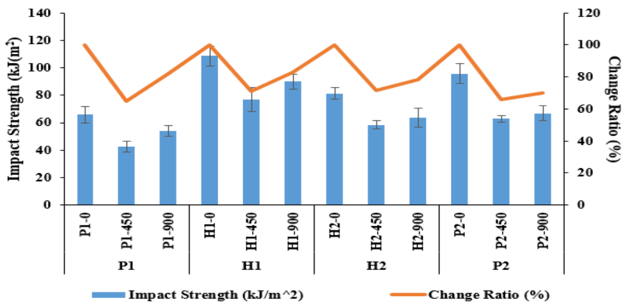
Figure 3. Schematic illustration of a) flatwise and b) notchwise Charpy impact test

3. Results and Discussions

The effects of UV aging duration and hybridization on the impact properties of the composite plates were systematically evaluated using both flatwise and notchwise Charpy impact tests. The results provide critical insights into how UV exposure influences the impact strength and energy absorption of different composite configurations. The impact strength and absorbed energy amounts for the flatwise Charpy impact test of the composite materials are presented in Figure 4 a) and b). In addition, the impact strength and absorbed energy amounts for the notchwise Charpy impact test are presented in Figure 5 a) and b).

It is clear that the composite fabric alignments have an effect on the impact properties of the materials for both the UV aging and control groups. The flatwise Charpy impact test results indicate that both UV aging and hybridization have significant effects on the impact strength and energy absorption of the composites.

a)



b)

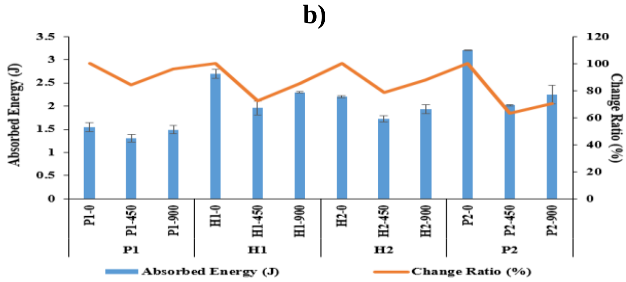


Figure 4. Flatwise Charpy Impact Test Graph a) Impact Strength b) Absorbed Energy

The flatwise Charpy impact test results of unaged samples showed that the highest flatwise impact strength was achieved by the H1 hybrid configuration (108.54 kJ/m²), followed by P2 (95.63 kJ/m²), H2 (81.26 kJ/m²), and the lowest for the non-hybrid P1 (65.77 kJ/m²). This suggests that hybridization, especially the glass-aramid-glass combination (H1), significantly improves the impact performance compared to pure configurations. Similarly, in terms of energy absorption, the P2 composite, composed entirely of aramid fabric, showed the highest energy absorption (3.2 J), whereas P1 absorbed the least (1.55 J). Both hybrid composites, H1 (2.7 J) and H2 (2.2 J), demonstrated intermediate values, confirming the effectiveness of hybridization in enhancing energy absorption. Flatwise impact test results are given numerically in Table 2.

When the results of the samples subjected to impact testing after 450 hours of UV aging were examined, there is a noticeable reduction in flatwise impact strength across all configurations after 450 hours of UV aging. P1 exhibited the most significant decrease (from 65.77 kJ/m² to 42.51 kJ/m², a 35.37% drop), highlighting the vulnerability of pure glass/epoxy to UV degradation.

Hybrid configurations again demonstrated superior durability under UV exposure. The impact strength for H1 dropped by approximately 29% to 77.04 kJ/m², while H2 saw a 28.18% decrease to 58.36 kJ/m². This shows that the hybrid composites, particularly H1, offer better UV resistance than the non-hybrid groups.

Energy absorption also followed a similar trend, with reductions observed for all configurations. P1 retained 1.31 J of absorbed energy (a 15.48% reduction), while H1 (1.96 J) and H2 (1.73 J) showed smaller relative decreases, confirming the protective role of aramid fibers against UV-induced degradation.

When the long-term (900 hours) accelerated UV aging results are carefully examined, after 900 hours, the impact strength of all composites showed signs of recovery or stabilization compared to the 450-hour results. For instance, P1 recovered slightly to 54.02 kJ/m², but this still represents an 17.87% reduction compared to the control group.

The hybrid configurations maintained their advantage, with H1 (90.01 kJ/m²) and H2 (63.59 kJ/m²) demonstrating improved resistance to UV exposure over time. This could be attributed to the redistribution of stress and better fiber-matrix interaction in hybrid systems, which helps mitigate further UV-induced damage [20].

Energy absorption values followed a similar pattern of recovery. P1 showed slight improvement to 1.49 J, while the hybrids H1 and H2 absorbed 2.3 J and 1.93 J, respectively. This suggests that the aramid layers within the hybrid configurations slow down the degradation process caused by prolonged UV exposure.

The notchwise Charpy impact test results provide a more detailed understanding of the fracture resistance of the composites under UV aging. These results further highlight the protective effects of hybridization. Notchwise impact test results are given numerically in Table 3.

Table 2. Flatwise Impact Properties of Samples

FLATWISE IMPACT TEST (Impact Strength kJ/m2)											
P1			**H1**			**H2**			**P2**		
P1-0	P1-450	P1-900	H1-0	H1-450	H1-900	H2-0	H2-450	H2-900	P2-0	P2-450	P2-900
65.77	42.51	54.02	108.54	77.04	90.01	81.26	58.36	63.59	95.63	62.97	66.82
FLATWISE IMPACT TEST (Absorbed Energy (J)											
P1			**H1**			**H2**			**P2**		
P1-0	P1-450	P1-900	H1-0	H1-450	H1-900	H2-0	H2-450	H2-900	P2-0	P2-450	P2-900
1.55	1.31	1.49	2.7	1.96	2.3	2.2	1.73	1.93	3.2	2.02	2.25

Table 3. Notchwise Impact Properties of Samples

NOTCHWISE IMPACT TEST (Impact Strength kJ/m^2)											
P1			**H1**			**H2**			**P2**		
P1-0	P1-450	P1-900	H1-0	H1-450	H1-900	H2-0	H2-450	H2-900	P2-0	P2-450	P2-900
115.69	64.08	71.8	127.95	102.68	114.44	148.56	88.4	93.65	155.04	119.07	141.39
NOTCHWISE IMPACT TEST (Absorbed Energy (J)											
P1			**H1**			**H2**			**P2**		
P1-0	P1-450	P1-900	H1-0	H1-450	H1-900	H2-0	H2-450	H2-900	P2-0	P2-450	P2-900
2.9	2.3	2.52	3.1	2.9	2.95	3.6	2.37	3	4.8	3.57	4.07

The control group results for notchwise impact strength were significantly higher than flatwise, with P2 (entirely aramid) achieving the highest value (155.04 kJ/m²), followed by H2 (148.56 kJ/m²), H1 (127.95 kJ/m²), and P1 (115.69 kJ/m²). This indicates that both aramid-based composites (P2 and H2) excel in notchwise impact resistance due to the superior toughness of aramid fibers. In terms of energy absorption, P2 once again demonstrated the highest energy absorption (4.8 J), followed by H2 (3.6 J) and H1 (3.1 J). These results suggest that aramid layers in hybrid or pure form are critical in enhancing impact toughness. Similar to the flatwise results, notchwise impact strength decreased across all configurations after 450 hours of UV exposure. P1 exhibited the sharpest decline (from 115.69 kJ/m² to 64.08 kJ/m², a 44.61% reduction), indicating significant UV-induced degradation in glass-based composites. H1 and H2 showed better retention of notchwise impact strength, with reductions to 102.68 kJ/m² and 88.4 kJ/m², respectively. The smaller reductions in the hybrid configurations emphasize their better durability under UV exposure.

Energy absorption also dropped, with P1 absorbing 2.3 J after 450 hours of UV aging (a 20.69% decrease). H1 (2.9 J) and H2 (2.37 J) displayed greater resilience, confirming that hybrid composites exhibit better energy absorption retention under UV aging.

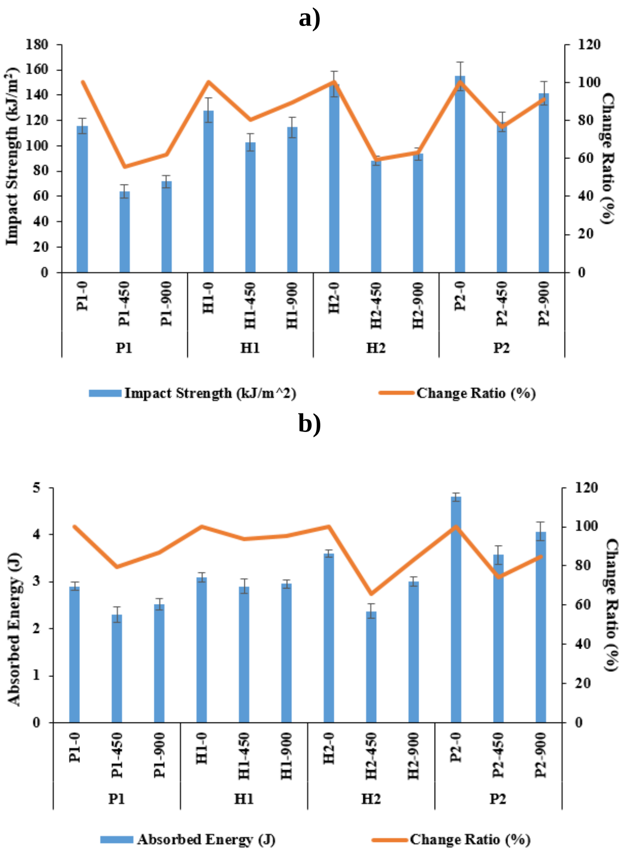


Figure 5. Notchwise Charpy Impact Test Graph a) Impact Strength b) Absorbed Energy

After 900 hours, the notchwise impact strengths showed slight improvements compared to the 450-hour results. P1 increased to 71.8 kJ/m², indicating some recovery, but this value still reflects significant UV-induced damage. Both hybrid composites, H1 (114.44 kJ/m²) and H2 (93.65 kJ/m²), demonstrated relatively stable performance, showing that the incorporation of aramid and glass layers helps reduce the long-term effects of UV exposure.

Energy absorption similarly recovered, with P1 absorbing 2.52 J, while H1 and H2 absorbed 2.95 J and 3.0 J, respectively. This trend suggests that hybridization offers not only better mechanical stability but also enhanced energy absorption capabilities over prolonged UV exposure [15,25].

In interpreting the observed changes in impact properties after 450 and 900 hours of UV aging, it is important to carefully consider the complex degradation and recovery mechanisms at play, while also acknowledging the overall decline in impact performance relative to the initial (0 hours) condition.

The significant decrease in impact strength and energy absorption after 450 hours of UV exposure can be primarily attributed to photooxidation [21,22] of the matrix and fibers, especially in the composites containing glass fibers (P1 and the hybrid groups). Prolonged exposure to UV radiation causes the breakdown of polymer chains in the epoxy matrix, leading to embrittlement and micro-cracking on the surface. These cracks weaken the matrix’s ability to effectively transfer stress to the reinforcing fibers during impact, resulting in reduced impact strength.

Additionally, during the initial stages of UV exposure, fiber-matrix interface degradation occurs [23]. The epoxy matrix begins to lose its ability to bond with the reinforcing fibers, especially in glass fiber-dominant composites like P1, where this interface weakening leads to higher vulnerability to UV degradation. This effect was particularly pronounced in the notchwise tests, where the introduction of stress concentrators like notches can exacerbate the impact of UV-induced surface degradation, leading to sharp reductions in impact strength.

Interestingly, after 900 hours of UV aging, there is a partial recovery or stabilization in impact properties compared to the 450-hour results. This recovery can be attributed to reorientation of the matrix and fibers [14,15]. As the UV exposure continues, the surface degradation might slow down, and the material could experience some internal reorganization, such as localized stress relaxation or improved fiber-matrix bonding in areas that have been less affected by surface-level damage [21,24]. This may allow the material to better distribute impact loads, temporarily improving its impact properties.

Despite the partial recovery observed after 900 hours, it is crucial to recognize that the impact properties of all composite groups still show an overall decline compared to the 0-hour condition. This general decrease is indicative of permanent damage caused by UV exposure that cannot be fully reversed by internal reorganization or crystallization. The UV-induced breakdown of the matrix, combined with the weakening of the fiber-matrix interface, results in long-term degradation that reduces the material's ability to withstand impact loads effectively.

4. Conclusion

In this study the effects of UV aging and hybridization on the impact properties of composite plates manufactured using glass and aramid fabrics in four different configurations: pure glass/epoxy (P1), pure aramid/epoxy (P2), glass/aramid/glass (H1), and aramid/glass/aramid (H2) was investigated experimentally. The composites were subjected to UV aging for 0, 450, and 900 hours, and their impact properties were evaluated through flatwise and notchwise Charpy impact tests. The results revealed significant insights into how UV exposure and hybridization influence the durability of these composites. UV aging resulted in a notable reduction in both impact strength and energy absorption across all configurations, particularly after 450 hours of exposure. This decrease was attributed to photooxidation of the epoxy matrix, leading to surface embrittlement and weakened fiber-matrix interactions. After 900 hours of UV exposure, a partial recovery in impact properties was observed, likely due to internal matrix reorganization. However, despite this recovery, the overall impact properties remained lower than the initial (0 hours) condition, indicating permanent UV-induced damage. Despite the partial recovery after 900 hours, all composites showed an overall decline in impact properties compared to their unaged (0 hours) state. Based on the results and analysis in this study, UV aging significantly impacts the impact properties of both hybrid and non-hybrid polymer-based composite materials. Exposure to UV radiation for both 450 and 900 hours led to measurable declines in impact strength and energy absorption, with more pronounced degradation observed after 450 hours. Specifically, non-hybrid samples, such as the glass/epoxy (P1), exhibited the highest susceptibility to UV-induced damage, with flatwise impact strength decreasing by 35.37% after 450 hours. Hybrid composites, especially those with aramid fibers (H1 and H2), demonstrated greater resilience, showing reductions in flatwise impact strength of only 29% and 28.18%, respectively, highlighting the protective role of aramid fibers against UV degradation.

After 900 hours of UV exposure, a slight recovery in impact properties was observed across all configurations, potentially due to matrix reorganization and stress relaxation within the composites. Despite this partial recovery, all UV-aged samples maintained lower impact strength and energy absorption values than their non-aged counterparts, underscoring the irreversible effects of UV exposure. For example, the flatwise impact strength of the glass/epoxy configuration (P1) declined by 17.87% relative to the control, whereas the glass-aramid-glass hybrid (H1) and the aramid-glass-aramid hybrid (H2) configurations showed reductions of 17.07% and 21.75%, respectively. These findings emphasize the durability limitations imposed by UV aging on epoxy-based composites and support the conclusion that hybridization, particularly with aramid fibers, enhances UV resistance. This study provides valuable insights for applications requiring long-term UV exposure, highlighting hybrid composites as more robust options for impact-resistant applications in UV-intensive environments.

Declaration

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. The author(s) also declared that this article is original, was prepared in accordance with international publication and research ethics, and ethical committee permission or any special permission is not required.

Author Contributions

Zeynal Abidin OĞUZ: Investigation, Methodology, Writing- Original draft preparation, Reviewing and Editing.

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