

# Using graphene in coating materials to prevent UV degradation on advanced composite materials

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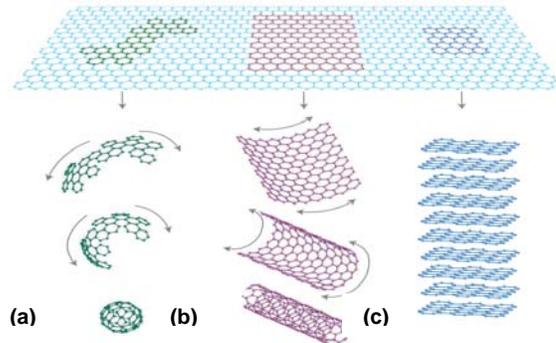
**Abstract.** The objective of the project presented here was to develop a new nanocomposite coating materials for protection of advanced fiber reinforced composite wind turbine blades against UV degradation and corrosion from weathering. TRIZ method was initially used to create the ideas about how to solve the challenging situation about advanced composite materials having a weak property to sustain UV degradation with its high specific modulus. This paper discussed about to apply graphene as inclusion in coating material, and it successfully increase its ability to resist degradation from Ultraviolet. The results were compared in mechanical strength, water contact angle test, and AFM surface study.

## 1. Introduction

Composite materials will eventually be applied for a wide variety of applications in industries such as aerospace and automobiles. As green energy is the trend to be used, wind-power energy is getting more attention in both industrial and academic research. Using composite materials for wind-power turbine blade has many tremendous advantages, such as, weight saving, higher specific strength, energy transition efficiency, however, it faces damage or degradation from UV light due to environmental exposure. The most researches show the lifetime of the convention coating methods and materials are much shorter than lifetime of the composite materials itself[1].

A new coating material was developed by adding the graphene powder as inclusion in paint, and using air-gun to spray them on surface of advanced composite materials. Recently, graphene has drawn a lot of research attention in materials science due to its special nano-properties and it has certain advantages over silicone material, which is the traditionally used material [2]. Graphene is the strongest known material so far. It has a fundamental structure of carbon nano-tubes and fullerenes [3](Figure 1). It has a-atom-thick allotrope of carbon with planer honeycomb lattice. More importantly, it is inert, and it has very high aspect ratios, which is an important factor to be utilized in coating industry and academic research. Contact angle property and AFM image are

the other important factors to be studied and analyzed.



**Figure 5 Mother of all graphitic forms[3].** Graphene is a 2D building material for carbon materials of all other dimensionalities. It can be (a) wrapped up into 0D buckyballs, (b) rolled into 1D nanotube or (c) stacked into 3D graphite.

## 2. Experiment

The nanocomposite coatings are prepared by individually combining inorganic nanoparticulates into polymeric matrices, and then sprayed on advanced composite materials at 3ml thickness. Air nozzle spray coating method is used in this study. Once the specimens were coated, according to ASTM B117, they were put into UV chamber for 4, 8, 12, and 16 days to observe damage differences. The UV intensity of 16 days exposure is equivalent to 2 years of regular sunlight in Wichita, KS. In the meantime, specimens were put into salt fog corrosion chamber for simulating the real weathering conditions.

## 3. Results and Discussion

Following are the tensile tests, new water contact angle tests, and AFM studies on the coating specimens after UV and salt corrosion exposure. From previous research, it tells UV radiation damages glass-fiber composite material about 1% every year[4], and my research clearly shows that UV radiation reduces the elastic modulus by 2% in glass-fiber coated with pure paint coating as compared to glass fiber coated with 2% graphene inclusions in

coating after about 2 years sunlight UV intensity (Figure 2).

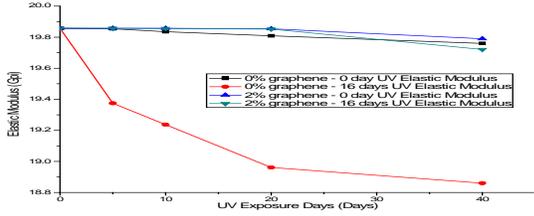


Figure 6 Elastic Modulus Comparisons

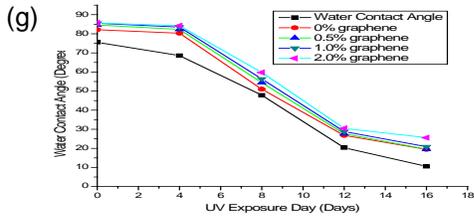
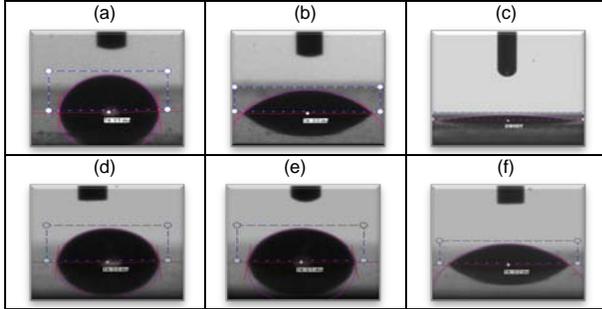


Figure 7 Water contact angle comparisons. (a) 0% Graphene, 0 days UV exposed (b) 0% Graphene, 8 days UV exposed (c) 0% Graphene, 16 days UV exposed (d) 2% Graphene, 0 days UV exposed (e) 2% Graphene, 8 days UV exposed (f) 2% Graphene, 16 days UV exposed (g) overall contact angle tests comparison

Water contact angel test shows the surface characteristic, roughness, and surface energy[5]. There are two kinds of surface properties, hydrophilicity and hydrophobicity. Different applications require a different specific surface roughness. This experiment needs the surface to show water-repellent properties. From Figure 3, UV lights damage the surface roughness, and water contact angle decreases as UV exposure days increases, however, by adding up graphene as inclusion in pure painting, it shows the water contact angle decreases less. AFM images Figure 4, (a), (c), and (e) are the images of glass-fiber with pure paint, exposed to UV light for 0 days, 16 days UV exposure, and 16 days UV exposure with 40 days corrosion test respectively, the surface roughness deteriorates rapidly (e) shows the worst surface over all. Image (b) shows a smooth surface as image (a),

but with graphene particles on surface, (d) and (f) images are damaged, but not as bad as (c), (e).

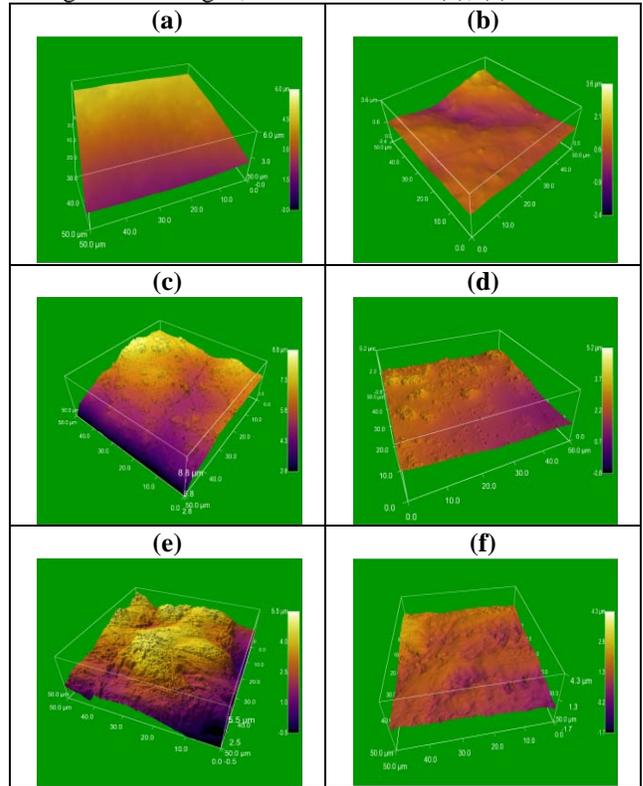


Figure 8 AFM images, (a) 0% Graphene, 0 days UV exposed, 0 day corrosion (b) 0% Graphene, 16 days UV exposed, 0 days corrosion (c) 0% Graphene, 16 days UV exposed, 40 days corrosion (d) 2% Graphene, 0 days UV exposed, 0 days corrosion (e) 2% Graphene, 16 days UV exposed, 0 day corrosion (f) 2% Graphene, 16 days UV exposed, 40 days corrosion

#### 4. Conclusions

The tensile test, water contact angle test, and AFM imaging shows that graphene is a good inclusion to be mixed with original paint. It helps maintain tensile strength, it helps prevent surface from UV damages and degradations

#### 5. References

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