MONASH University

MONASH INNOVATION

GRAPHENE COATING FOR CORROSION PROTECTION OF STEEL

Multi-layer graphene as a coating has beneficial properties when it comes to resisting corrosion. Coating multi-layer graphene onto mild steel for corrosion resistant applications has not been possible until now. We have developed a method of coating mild steel using chemical vapour disposition for multi-layers of graphene with functional intermediate layers.

- **Highly resistant to chemical reaction.**
- **Tough coating of complex shapes.**
- **Multi-layer graphene by chemical vapour disposition**

THE CHALLENGE

Graphene coating of metals has been shown to produce excellent corrosion resistance. Among the various methods of preparation, chemical vapour disposition (CVD) is one the most promising as this method can produce high quality graphene coating.

Some issues encountered when attempting to coat mild steel with graphene through CVD are:

- CVD causes carbon to be produced at the surface due to catalytic dissociation of a hydrocarbon.
- Catalytic efficiency of iron and its alloys is much less than copper and nickel substrates, which are commonly used to synthesize graphene coating.
- Iron alloys and nickel have very high solubility of carbon at CVD temperatures (800-1000˚C).
- Excessive carbon diffusion is known to cause steel to become brittle.

Clearly a method of production is needed which addresses these issues, having a steel surface with an efficient catalytic property for CVD coating with the least possible carbon solubility.

THE SOLUTION

Graphene has been coated on to non-steel substrates in the past with much success. When mild steel is coated with our first intermediate layer and then coated with graphene we see diffusion of iron (Fe) across the intermediate layer, which hinders the formation of graphene. The solution is to add another thin layer of metal between the mild steel and first layer. The second layer should:

- have low solubility of carbon
- not hinder graphene deposition
- have considerably lower solubility of iron than in the first layer.

The novel surface coating developed by Monash researchers is a substrate of mild steel with two intermediate layers between it and the graphene.

The thickness of each of the layers is in the order of tens of micrometers and has been optimized to maximize the adhesion strength.

Setting the thickness of the layers is a non-trivial task, as the layer must prevent excessive carbon accumulation during CVD.

Figure 1 compares the corrosion resistance of mild steel and graphene-coated mild steel after 1008 hours of immersion in an aggressive salt bath. The results show dramatic improvement in corrosion resistance for our novel surface coating. Figure 2 shows SEM results.

THE OPPORTUNITY

Monash seeks a partner to license this patented technology (AU2019900664) for further development and to assist in bringing a practical application to market.

The Monash team behind this innovative technology is led by Professor Raman Singh, Faculty of Engineering.

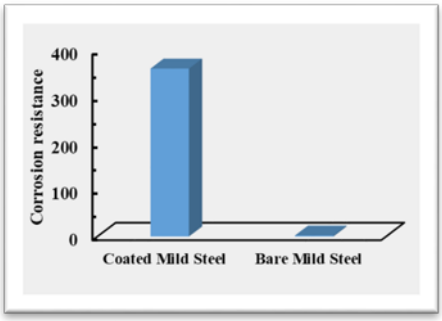

Figure 1. Corrosion resistance of graphene-coated vs. uncoated mild steel.

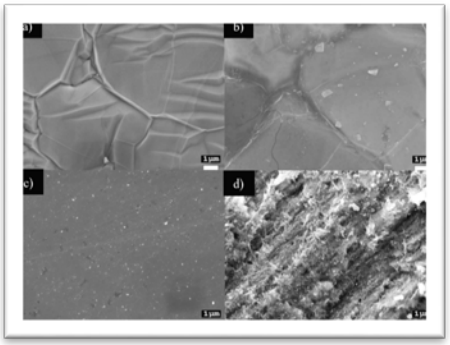

Figure 2. SEM results for (1) graphene-coated and (2) uncoated mild steel following 1008 hours of immersion in an aggressive salt solution.

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