Plastics in Corrosion Resistant Applications

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Key Terms

Corrosion: A natural process that converts a refined metal into a more chemically stable oxide or hydroxide by chemical or electrochemical reaction with the environment.
Corrosion resistant: The the ability to withstand deterioration of properties caused by chemical or electrochemical reactions.

Introduction

Corrosion has been the focus of researchers and industrialists due to its adverse effect in terms of economic importance, safety concerns, and environmental contamination. Corrosion is defined as an irreversible interfacial reaction between a material and its environment which results in consumption of the material or degradation in its properties (Czichos *et al.*, 2011; Cwalina, 2014). The corrosion of metals can also be defined as the destructive chemical or electrochemical reaction of a metal with water, oxygen, sulfur, etc. found in the surrounding (Hiromoto, 2019). Metallic corrosion is inevitable as it is the thermodynamic stabilization process for a metal, reverting to its stable oxide or sulfide form. From the thermodynamic point of view, potential difference between anodes and cathodes is the driving forces in any electrochemical reaction (Czichos *et al.*, 2011; Burt, 2015). The removal of either anode, cathode or the electron-conducting path is the basic concept of corrosion control. Corrosion of metal is commonly known as rusting.

Corrosion Mechanism

In the efforts to overcome metallic or non-metallic corrosion problems, the thorough knowledge about the interactions between the substrate and the material is crucial. In general, corrosion mechanism can be classified into electrochemical, chemical, and physical reactions. Electrochemical reaction is regarded to the metallic corrosion. Components that involved in this reaction are anode, cathode, electrolyte, and metallic path as shown in **Fig. 1**. This reaction corresponded to the electrolyte composition, the interfacial reactivity of the metal with respect with the service environment, the physical-chemical oxidation and reduction process occurs on the metal surface (Berradja, 2019). In general, metallic corrosion refers to oxidation process occurs at anode where metal atoms dissolve into the electrolyte as metal ions. This process involves metal with higher reactivity to release electrons. Electrons generated will be transferred to cathode and consumed for reduction reaction to occur, thus rust will be deposited at cathode site. The anodic and cathodic reactions occur simultaneously at equal rate to form an electrical circuit where electrons conduction occurs in the metal substrate and ionic conduction in electrolyte (Pehkonen and Yuan, 2018).

On the other hand, chemical corrosion of metallic material is the corrosion of metal under non-electrolytes or dry conditions (Pehkonen and Yuan, 2018). It is subject to the basic laws of chemical kinetics of heterogeneous reactions, without the generation of electric current. Physical corrosion of metallic material is based on the penetration of the liquid metal into the grain boundaries

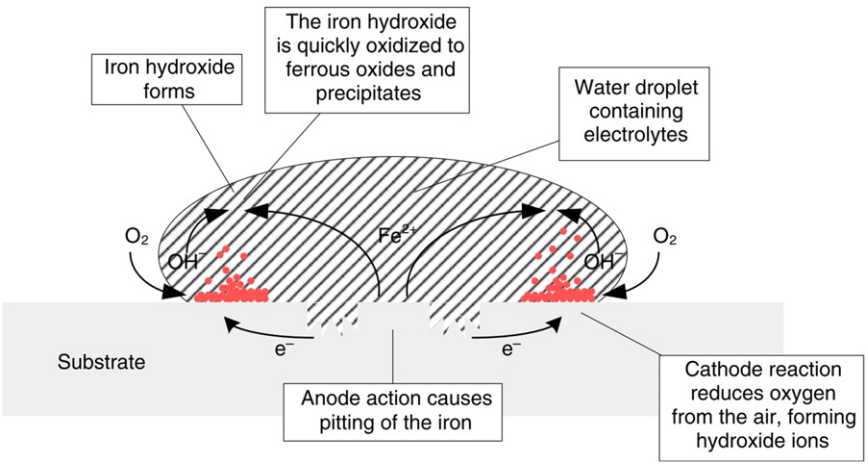

Fig. 1 Corrosion mechanism of iron-based material. Reprint with the permission from Sørensen, P.A., Kiil, S., Dam-Johansen, K., Weinell, C.E., 2009. Anticorrosive coatings: A review. Journal of Coatings Technology and Research 6, 135–176, Copyright (2020), Springer Nature.