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Valorization of natural extracts as corrosion inhibitors

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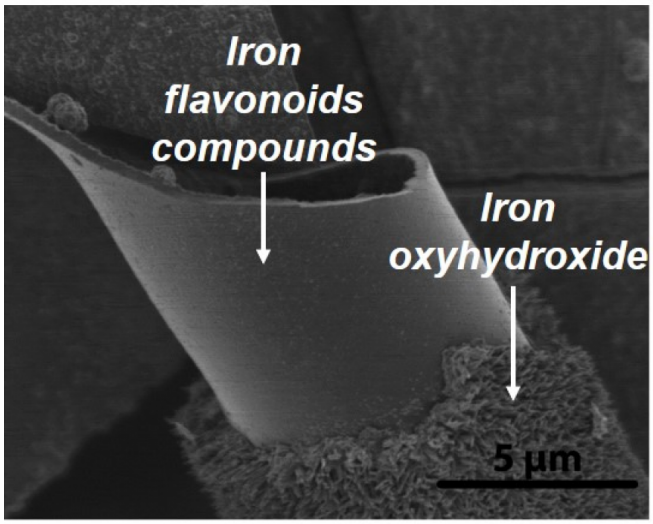
PURPOSE OF THE ABSTRACT
In the framework of new ecological challenges, many extracts from natural ressources appear as promising green corrosion inhibitors. Their efficiency is generally attributed to the antioxidant properties of secondary metabolites, as flavonoid molecules, which are produced by plants in order to fight against environment attacks. However, due to the large number of molecules contained in plant extracts, the corrosion inhibition basic mechanisms remain largely unknown. This paper focuses on the inhibiting effect on steel corrosion of various molecules contained in an orange peel diluted extract.

In acidic medium, polarization measurements and electrochemical impedance spectroscopy (EIS) measurements, performed in HCl 0.1 M in a water/ethanol medium, show slight inhibition efficiency (both anodic and cathodic) of pure flavonoid molecules, through an adsorption mechanism, directly linked to their structure. Actually, the best performances are obtained with molecules characterized by two adjacent OH groups on the B-ring (catechol group), which explains the chelation of Fe2+. Regarding the anticorrosion efficiency of a diluted natural extract, it is enhanced compared to isolated flavonoid molecules (naringin, neohesperidin) thanks to the formation of a thick surface film with organic macromolecules, limiting the diffusion of oxidant species, as revealed by both SEM observations and EIS data.

In more alkaline medium, at pH 4, the corrosion behavior is governed by the formation of a tri-dimensional conversion film made of iron and flavonoid, as revealed by SEM observations. For a deeper understanding, the corresponding organo-metallic compounds were synthesized from precipitation at pH 4 of iron salt in presence of flavonoid molecules and investigated by Raman spectroscopy and X-ray Absorption Spectroscopy measurements (XAS). Results show that the formation of conversion products requires the octahedral coordination of Fe3+ by the O atoms of the catechol group attached to the B-ring. From an electrochemical point of view, a cathodic inhibition attributed to the oxygen scavenger role of the antioxidant molecules was observed. Nevertheless, the anodic protection depends on the covering properties of the conversion film (when it is formed), related to the molecule structure.

FIGURES



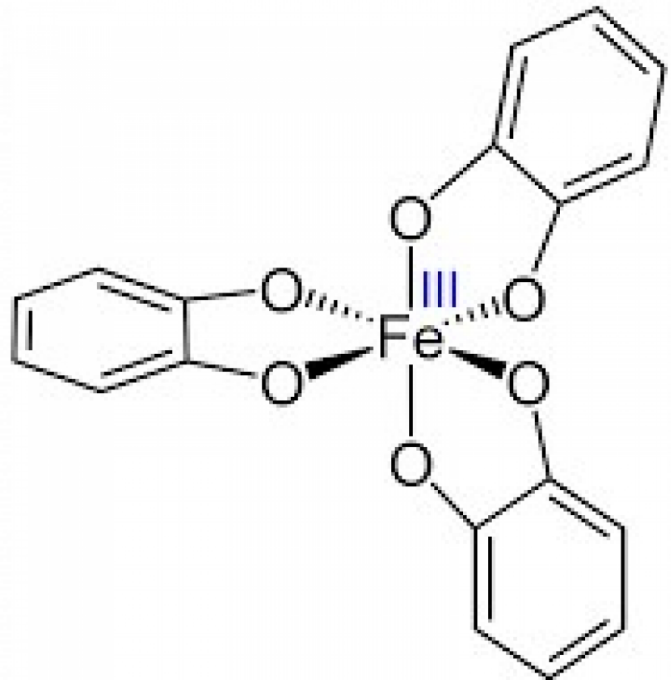


FIGURE 1
Passive film

Passive film formed at pH 4 on steel in presence of flavonoids (peel off part)

FIGURE 2
Iron catecholate

Iron catecholate coordination

KEYWORDS
orange peel extract | passive film | flavonoids | corrosion

BIBLIOGRAPHY