Research

Ir. Ts. Dr. Juliawati produces microcapsules composed of honey and linseed oil to enhance metal corrosion resistance

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PEKAN, 20 September 2023 - The cost of repairing or maintaining automotive components, oil and gas pipelines, and the like is not cheap and requires suitable and effective methods to protect metals and materials from corrosion.

Addressing this challenge, Ir. Ts. Dr. Juliawati Alias, Head of Programme for Bachelor of Mechanical Engineering (Automotive) at Faculty of Mechanical and Automotive Engineering Technology (FTKMA), Universiti Malaysia Pahang Al-Sultan Abdullah (UMPSA), has developed microcapsules containing honey and linseed oil. These microcapsules act as corrosion inhibitors in paint, forming a smart coating.

According to her, the microcapsules are formed in a spherical shape with sizes ranging from 30 to 70 micrometres, depending on the agitation rate.

“These microcapsules will be added to the epoxy and hardener mixture in a suitable ratio or proportion.

“Smart coating functions as a self-healing mechanism, automatically releasing rust inhibitors when any scratches occur on the painted surface, thereby minimizing the risk of metal surfaces rusting.

“Based on corrosion tests conducted, it is evident that the corrosion rate of metal decreases by over 99 percent. The corrosion rate per year for untreated or coated metal is 23.1 mm/y, while for metal coated with smart coating, it is significantly lower at 0.001 mm/y," she explained.

This research, initiated in 2019 and funded by the KPT research grant, also involved collaboration with FTMKA lecturer, Dr. Nasrul Azuan Alang, and FTKMA master's student, Nurul Amiratul Johari. The project was completed in November 2022.

MICROENCAPSULATED HONEY FOR INTELLIGENT AND FUTURE PAINT

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Project background

- The product that has been developed is microencapsulated honey embedded in epoxy coating which act as a novel and intelligent paint.
- Microencapsulated honey is embedded in epoxy resin paint as a corrosion inhibitor agent of novel intelligent paint to self-heal scratches or damages of metal surface and enhance corrosion resistance of metal alloy components.
- Microcapsules are formulated by mixing poly-urea formaldehyde (PUF), resorcinol, ammonium chloride,and polyvinyl alcohol as the shell for the microcapsules. Linseed oil, aloe-vera and honey as the core content of the microcapsules.
- Addition of honey extract with variation concentration was found to be beneficial as a corrosion inhibitor for long-term corrosion protection of metal surface, as well as agent of self-healing paint.

State of the Art/ Methods

Ingredients:

Shell of microcapsules:

- Urea
- Formaldehyde
- Polyvynil Alcohol
- Ammonium chloride
- Resorcinol
- Distilled water

Corrosion inhibitor agent (core content of microcapsules):

- Linseed oil
- Honey (40 wt.%)
- Aloe-vera

Novelty/Originality

- A novel ingredient for intelligent paint
- Full self-healing of any scratches less than 4 days
- A green and safe corrosion inhibitor for metal protection
- Reduce more than 99% corrosion rate of metal structure
- Easily available material
- Green corrosion inhibitor

Product Characteristics

40 wt.% Honey extract (Main corrosion inhibitor agent)

Microcapsules formulation with added 40 wt.% honey

Filtered and dried microcapsules

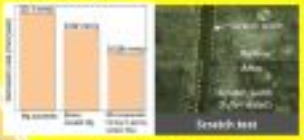
Dried microcapsules containing honey corrosion inhibitor (Product)

'Intelligent paint' (self-healing damage paint) with honey microcapsules

Product Performance/Result

Scratch fully healed after 4 days with no corrosion

Efficient for long-term corrosion protection method.



Corrosion rate (mm/y)	
Intelligent paint with honey	Metal substrate
0.03	23.1

Benefit/Usefulness

- Resist more than 99.9% corrosion susceptibility of Mg component
- Inexpensive and green materials
- Reduce corrosion maintenance and autonomously repairs damage on surface
- Enhance sustainable environment

Product Marketability

Total cost (microcapsules and epoxy paint) = RM120/500 ml

Market price: RM200/40 ml (Ceramic nano-coating)

Potential market: Industrial collaboration for oil and gas structure and automotive coating and corrosion inhibitors

Achievement/Award

- GOLD Award CITREX, 2022 (Green Technology)

Environmental Impact

- Green corrosion inhibitor
- Environmentally friendly paint ingredient (less volatile organic compound, VOC)
- Potential for safe waste

Status of Innovation

- TRL5 - 6
- UI2022002586 – Pembaharuan utiliti (UI) 2022: Microcapsules for self-healing coating
- Research and development under FRGS grant
- Potential industrial collaboration and trial use for metal structure coating

Publication

- Self-Healing Epoxy Coating with Microencapsulation of Linseed Oil for the Corrosion Protection of Magnesium (Mg), Journal of Physics: Conference Series, 2021 (Scopus indexed proceeding)
- Recent progress of self-healing coating, Journal of Coatings Technology and Research, 2022 (Scopus, WOS, Q2)
- Anti-corrosive coatings of magnesium: A review, Materials Today:Proceeding, 2021 (Scopus indexed proceeding)

She added that the concept of creating a smart coating originated when she contemplated the appropriate and effective methods to protect metals and materials from corrosion.

"The latest research indicates that the application of smart coating is highly effective in protecting metal components, sparking my interest to further investigation and study.

"However, the extent to which the manufacturing process, characterization, and performance translate with the modification of these microcapsules by adding honey as a rust inhibitor has been detailed in the application for the KPT research grant titled 'Interaction Mechanism of Self-Healing Epoxy Coating and Microencapsulated Inhibitor for Corrosion Protection of Magnesium Alloys,'" she said.

This product functions to enhance the long-term corrosion protection of metal or metal components and is available at a price of RM50 for 50 ml.

In the future, the product will be tested in real applications such as painting cars, pipes, or iron components.

The product has also won a gold medal at the Creative and Innovative Invention Competition (CITREX) 2022.

Additionally, it secured a silver medal at the International Invention, Innovation, and Technology Exhibition (ITEX) 2022 and CITREX 2021.

Apart from the microcapsules composed of honey and linseed oil, Ir. Ts. Dr. Juliawati has previously developed a motorbike roof shield and a corrosion test rig platform.

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