Synthesis and characterization of poly(urea)urethane hybrid coating derived from coconut oil-based polyester polyol for anti-corrosion application

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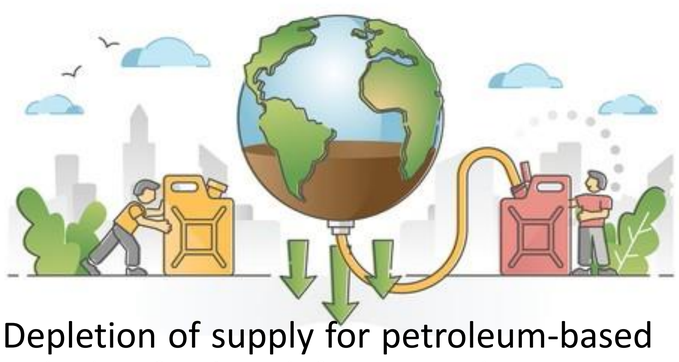
Abstract

In this study, a polyurethane/polyurea hybrid coating was successfully produced using a coconut oil-based polyol, a renewable material, and triethanolamine (TEA) as the amine source. The synthesized coating material was characterized by Fourier-transform infrared (FTIR) spectroscopy to evaluate the changes in the coating's chemical composition. The Corrosion Rate (CR) was evaluated using electrochemical methods, adhesion test using ASTM D-882, while hydrophobicity test using Water Contact Angle Tensiometer.

The FTIR analysis confirmed the occurrence of the structural characteristics of poly(urea)urethane hybrid coating and its composites (different levels of amine loading). A significant decrease in the corrosion rate was observed as the amine loading increased. In addition, increased adhesion strength and improvement in the hydrophobic properties of the coatings were observed as the amine loading increased. This study successfully produced coconut oil-based coatings that are potentially suitable for use as anticorrosive coating materials.

Introduction



Depletion of supply for petroleum-based polyol as feedstock for PU application.

Release of toxic chemicals and greenhouse gases from paints and coatings.

Shifting towards the use of Green Technology

Bio-based polyol CPP
Coconut polyester polyol

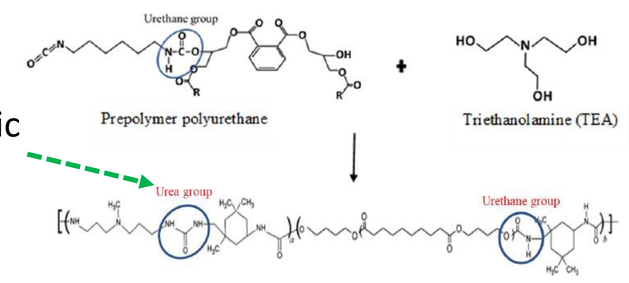
Anti-corrosion coating

Problem

- Polyurethanes are hydrophilic making it susceptible for corrosion attack.

Solution

- Incorporation of polyurea in the urethane matrix

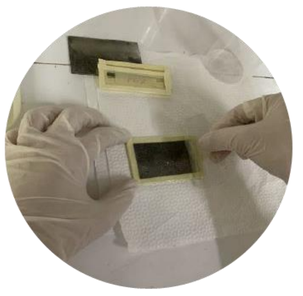


Hydrophobic
- Suitable as inhibitor for corrosive agents

Methodology

Synthesis

Pre-polymerization of PU and incorporation of TEA and addition of NCO to form PU.



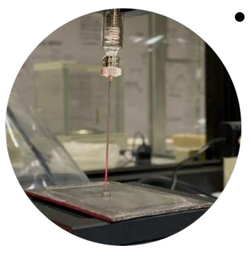
Application of PU-Urea hybrid coating on the metal substrate

Material Characterizations

- FTIR to determine the chemical composition of the sample

- Potentiostat to measure the performance of coating against corrosion.

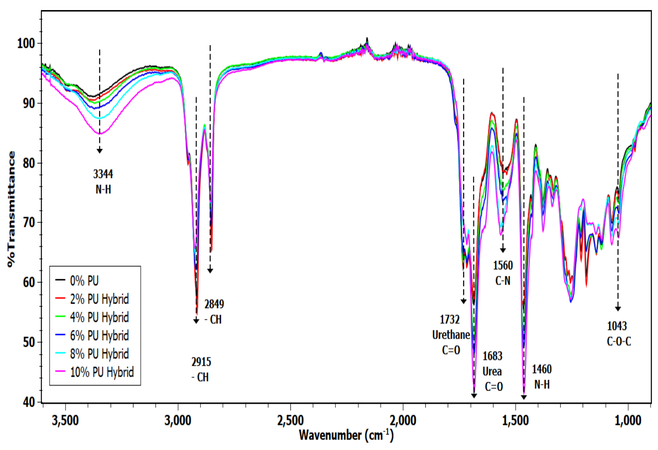
- Cross-cut test to determine the adhesion strength of the coating material.



- Water contact angle test to determine the hydrophobicity of the sample.

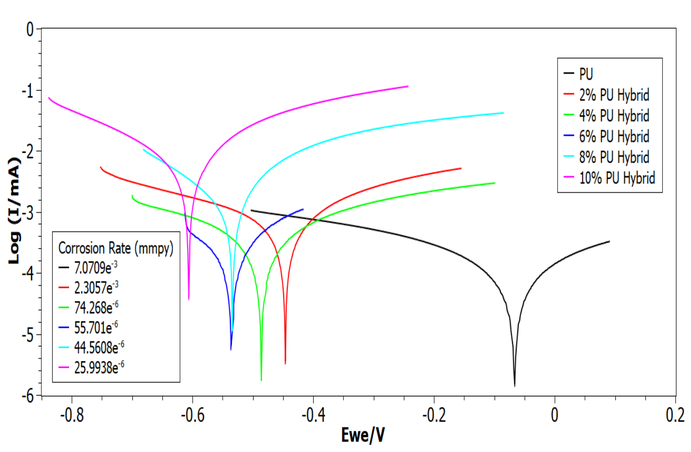
Results and Discussion

Organic composition analysis



- The FTIR spectrum of Poly(urea)urethane Hybrid shows signals in the peak of 3344 cm^{-1} which are the results of symmetric and asymmetric stretching vibrations of the N-H groups present in urethane derivatives.

Electrochemical analysis



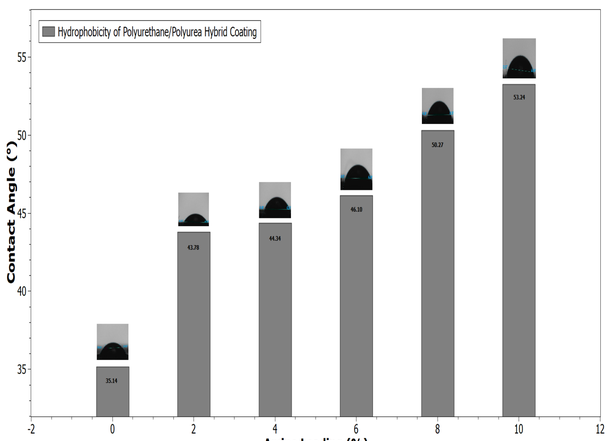
- The decreasing trend of the corrosion rate of the samples as the amine concentration increases could be due to the presence of higher amine content can be correlated with an increase in the hard segments and 3D cross-linked structure of the coating.

Adhesion strength test

Amine Loading (%)	Classification
0	3B
2	5B
4	5B
6	5B
8	5B
10	3B

- As the amount of amine incorporated increases, the adhesion showed to be excellent. The excellent adhesion of coatings could be attributed to the presence of urea linkages which form secondary hydrogen bonding with the substrate.

Hydrophobicity test



- The hydrophobic nature of polyurea would enhance the hydrophobicity of the coating surface, which inferior the interaction of the metal surface with electrolyte and improve the barrier property, thus enhancing the corrosion inhibition of the coating

Conclusion

In summary, the Polyurethane-polyurea hybrid coatings with varied amount of amine was successfully synthesized utilizing coconut oil-based polyol blend and TEA which was confirmed by the formation of urea and urethane linkages observed in the chemical structural analysis done by FTIR. Based on the anti-corrosion tests performed, there was a decrease in corrosion potential and corrosion current is accompanied by a sharp decrease in the corrosion rate which only suggests that better corrosion performance is attained with the addition of amine.Although the 10% TEA loading showed the best corrosion resistance, thermal stability, and hydrophobicity, a limitation was observed as the hard segments of the coating increased in which the film started to become brittle, thus, resulting in a decrease in tensile strength and adhesion. This limitation could affect the performance of the coating in the long run. Therefore, with these results, the researchers concluded that the best concentration of amine which has shown excellent thermal, mechanical and anti-corrosion properties was 8%.

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