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Surface Morphology and Wetting Behavior of the Aspidiotus spp. Scale Covers

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Abstract : The scale insects Aspidiotus destructor and Aspidiotus rigidus exhibit notable scale covers made of wax which provides protection against water loss and is capable to resist wetting, thus making them a desirable model for biomimetic designs. Their waxy covers enable them to infest mainly leaves of coconut trees despite the harsh wind and rain. This study aims to describe and compare the micro morphological characters on the surfaces of their scale covers consequently, how these micro structures affect their wetting properties. Scanning electron microscope was used for the surface characterization while an optical contact angle meter was employed in the wetting measurement. The scale cover of A. destructor is composed of multiple overlapping layers of wax that is arranged regularly while that of A. rigidus is composed of a uniform layer of wax with much more prominent wax ribbons irregularly arranged compared to the former. The protrusions found on the two organisms are formed by the wax ribbons that differ in arrangement with their height being A. destructor (3.57+1.29) < A. rigidus (4.23+1.22) and their density A. destructor (15+2.94) < A. rigidus (18.33+2.64). These morphological measurements could affect the contact angle (CA θ) measurement of A. destructor (102.66+9.78°) < A. rigidus (102.77 + 11.01°) wherein the assessment that the interaction of the liquid to the microstructures of the substrate is a large factor in the wetting properties of the insect scales is realized. The calculated surface free energy of A. destructor (38.47 mJ/m^2) > A. rigidus (31.02 mJ/m^2) shows inverse proportionality with the CA measurement. The dispersive interaction between the surface and liquid is more prevalent compared to the polar interaction for both Aspidiotus species, which was observed using the Fowkes method. The results of this study have possible applications to be a potential biomimetic design for various industries such as textiles and coatings.

Keywords : Aspidiotus spp., biomimetics, contact angle, surface characterization, wetting behavior
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