UNIVERSITI TEKNOLOGI MARA

SURFACE ANALYSIS OF BIO-INSPIRED PISTIA LEAVES

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of the requirements for the degree of
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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Bio-inspired surface is getting more attention in engineering applications. It allows mankind to take ideas from nature and mimic those ideas into various technology of structures, products and devices. On a close-up, surface in nature have micro and nano structures desirable and useful for engineering applications. Many, including Lotus and Roses, have been researched and the characteristics have been successfully translated to advanced engineering surfaces. Hairy structures on leaves surfaces have different characteristics which will affect the behaviour of fluid flow. Pistia Stratiotes or '*Kiambang*'; for example, has intrinsic oleophilicity surfaces which has not been widely explored. Thus, in this research, the structures of mature Pistia Stratiotes leaves were reproduced using casting method. Four different composites were fabricated which included epoxy, nanocomposites of graphene-filled, multiwalled carbon nanotube (MWCNT)-filled and nanoclay-filled. Three different types of oil namely palm oil, palm oil + TiO_2 and VG 68 oil were tested for static friction coefficient for real and inspired surfaces. The kinematic viscosity at 40 °C and 60 °C of oils was measured using capillary tube kinematic viscometer. The surface tension at 25 °C, 40 °C and 60 °C of oil was measure using DuNouy ring method tensiometer. The density of oil was conducted using temperature regulator attached with hydrometer. The morphological structures of the samples were observed using Variable Pressure Scanning Electron Microscope (VP-SEM) and Dinolite digital microscope. The wettability and oleophilicity behaviour of the real and inspired surfaces were measured using contact angle meter. The surface roughness of the pistia-inspired was examined using non-contact Alicona profilometer. The heat distribution of heated oils droplets at two different temperatures (40 °C and 60 °C) was also recorded to see the heat contour map and flow characteristics of the inspired surfaces. The patterns contours were captured using Infrared thermal imaging camera. Based on the experimental data, the microstructure of inspired surface was observed to be almost similar to the real surfaces for each nanocomposites material. The oil contact angle for palm oil, palm oil + TiO_2 and VG 68 on mature pistia leaves exhibited good oleophilicity with the value of 72.75 °, 5.49 ° and 6.21 ° respectively. The results for four inspired surfaces with similar types of oil (palm oil, palm oil + TiO_2 and VG 68) were also recorded and VG 68 oil droplet on graphene-filled exhibited the highest category called superoleophilicity as the value approaches 0°. For COF, mature pistia leaves exhibited the lowest values of 0.3057, 0.2309 and 0.3249, while graphene-filled inspired surfaces exhibited superior values of 0.3057, 0.3049 and 0.3488 for the case of palm oil, palm oil + TiO_2 and VG 68, respectively. In terms of surface roughness epoxy inspired surface recorded the highest value of 15.643. Oil surface tension and oil viscosity decreased when temperature increased for oil used. However, the heat distribution of the heated oil droplet affected the flow spread and the droplet temperature decreased after 30 s to 35 s the surface was tested. In conclusion, this oleophilicity screening on the pistia surface structure is useful as an alternative solution for tribological applications.

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