RIMAPS Description of the Micro-Nano Patterning of Leaf Surfaces

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It is known that RIMAPS (Rotated Image with Maximum Average Power Spectrum) technique allows finding the main directions of any surface topography and describing it by simple geometrical figures [1]. During the last years it has been applied to the study of metallic surfaces and biological samples [2] [3] [4]. This research work describes the micro-nano-patterning of the superhydrophobic *Colocasia esculenta* (Taro) leaf surface (adaxial side, dried samples from herbarium), by analyzing their RIMAPS spectra. This kind of analysis allows finding the preferential directions, determined by RIMAPS, of the micro-nano-structure pattern of the epidermic cells and epicuticular wax. Figure 1 shows the taro leaf at a low magnification (400x). The RIMAPS spectrum (figure 4, blue line, smoothed using a fast Fourier transform) is quite similar to the spectrum obtained by a combination of geometrical forms such as straight lines and a circle [1]. So, the micro-patterning of the surface can be represented by a simple circle (papillae morphology, even though the roundness of them has almost disappeared because of its shrinkage) plus many straight lines in different directions (cell boundaries and alignments of papillae), which means a quite uniform distribution of papillae. Figure 2 shows the same region as figure 1 but with a higher magnification (2000x). In this case the RIMAPS spectrum (figure 4, dark line) reveals more clearly the presence of the circle as one of the main geometrical forms that constitute the surface topography. The two hills or round forms of the spectrum between the main minima (85º and 170º) indicate the existence of a circle shape [1]. If we magnify even more (e.g. 40000x) to see the epicuticular wax situated between the papillae, the respective RIMAPS spectrum (figure 4, red line) results to be very similar to the RIMAPS spectrum of figure 2, with the difference that the circle shape has almost disappeared (no minimum at 85º). The topographical pattern developed by the epicuticular wax, which has a platelet shape (see figure 3), has identical main directions, similar distribution, as the pattern formed by the papillae and cells seen at 2000x. If we analyze the epicuticular wax covering the papillae (figure 5, 40000x), the RIMAPS spectrum (figure 6, red line) reveals also a similarity with spectrum of figure 2, which means that the circle shape appears again. This could be explained by the round distribution of the wax platelets on top of the papillae (see fig. 5). In conclusion, within a certain range of scales the angular distribution of the micro-patterning of the taro leaf formed by the epidermal cells and papillae agrees with the angular distribution of the nano-patterning of the leaf formed by the epicuticular wax, a fractal concept seems to be underneath. The next step is to study fresh samples and to find the range of scales (magnifications) where the RIMAPS spectra are similar. RIMAPS spectrum is a useful tool for analyzing the angular distribution of the micro-nano-patterning quantitatively and determining the main characteristics of the pattern.

References
[1] N.O. Fuentes and E.A. Favret, *Journal of Microscopy*. 206 (2002) 72-83.
[2] E.A. Favret et al., *Applied Surface Science*. 230 (2004) 60-72.
[3] E.A. Favret and P. Löthman, *Microscopy and Analysis*. 21(1) (2007) 7-9.

[4] E.A. Favret and N.O. Fuentes, *Functional Properties of Bio-Inspired Surfaces*. World Scientific Publishing Co. Singapore. 2009.
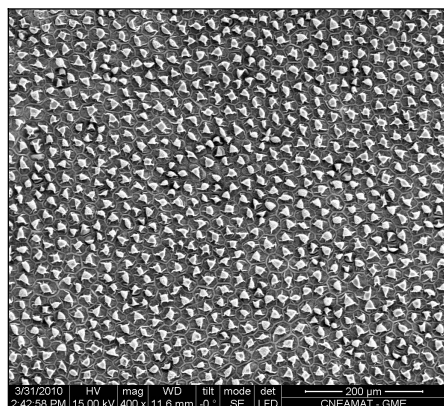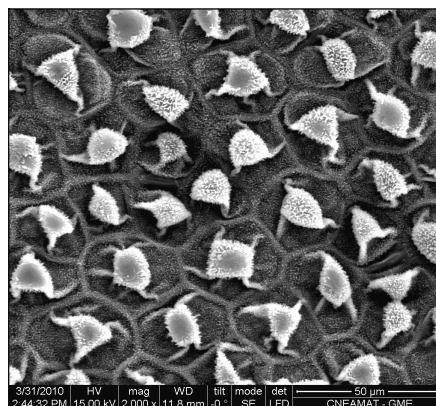

Figure 1. SEM image of the leaf surface

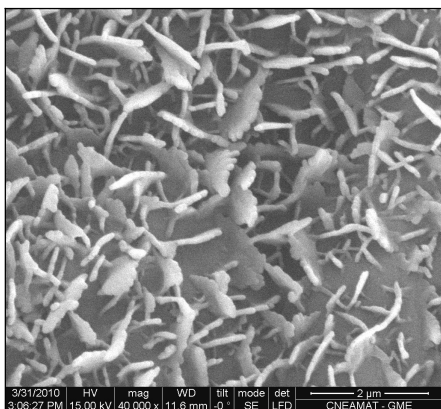Figure 2. SEM image with a higher magnification

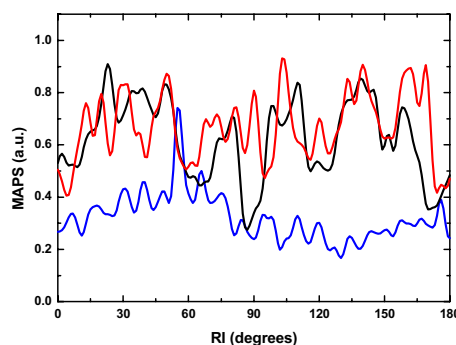Figure 3. SEM image of the epicuticular wax found between papillae

Figure 4. RIMAPS spectra of figs.1 (blue line), 2 (black line) and 3 (red line)
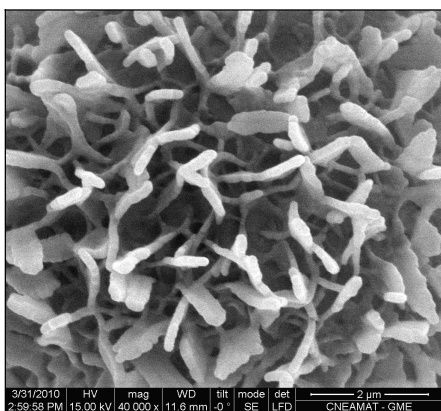
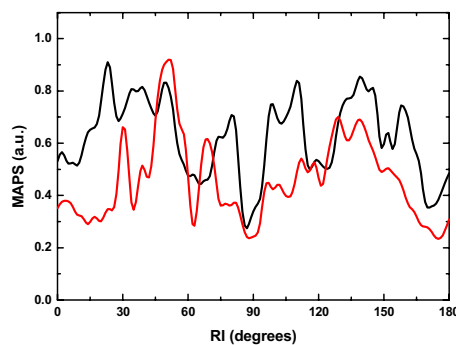

Figure 5. SEM image of the epicuticular wax covering the papillae

Figure 6: RIMAPS spectra of figs. 2 (black line) and 5 (red line)