Open positions

To accomplish the research proposed in our joint coordinated project

Nanoscale characterization of bio-wetting and its implication for plant growth and resilience (NanoBioWet)

we are looking for motivated researchers, with a strong background either in biology, biophysics, plant science, material science and/or optics. In addition, candidates should be willing to undertake interdisciplinary research and be open-minded to pursue new ideas and to discuss (and explain) research with other participants in the project, from different scientific disciplines.

The goal of the overall project is to extend the power of surface characterization techniques that are well established in Material Science, to leaf surfaces relevant for Plant Science and Agriculture. The focus will be on the one hand to solve basic and fundamental questions related to the wetting of plant surfaces; and on the other hand to apply this knowledge to clarify how water and foliar fertilizers interact with and may be adsorbed by plant leaves. This project is based on recent work where we showed that the difference between the Rose Petal and the Lotus Effects cannot be simply explained via surface roughness and has a key contribution of surface chemistry [1].

[1] Almonte L., et al. (2022). Rose petal effect: A subtle combination of nano-scale roughness and chemical variability.
https://onlinelibrary.wiley.com/doi/full/10.1002/nano.202100193
also been published (in spanish) in "standard press”:
https://theconversation.com/efecto-petalo-de-rosa-desvelado-uno-de-los-mayores-enigmas-de-las-superficies-biologicas-172441

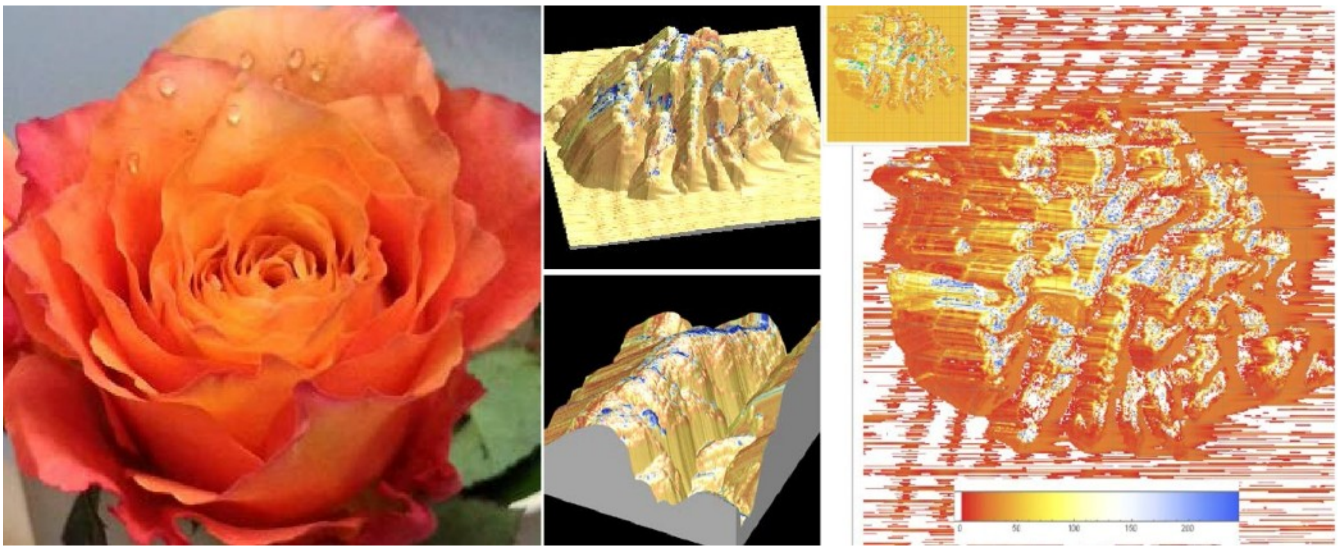

Figure 1. *Left: Rose Petal with small drops having high contact angle but nevertheless adhering to the petal surface. Middle: AFM images showing topography (vertical scale) and wetting properties (color of surface. blue: hydrophilic, red: hydrophobic). Image scales: top image (12.5μm)^2 and 4 μm height, bottom image (2.5μm)^2 and 2μm height. Right: Wetting parameter calculated from topography and local chemistry data.*

This interdisciplinary protect will be developed at the following institutions:

Universidad Politécnica de Madrid and Universidad Complutense de Madrid

Plant growth, plant response to heat and drought stress factors, application of silicon and other mineral element compounds for reducing plant stress, interaction of mineral solutions and particles with leaf surfaces and foliar absorption experiments, drop drying and re-hydration trials for assessing mineral dissolution-crystallization processes in plant surfaces, contact angle determinations, leaf anatomical characterization also using plant tissue dyes (OM), TEM and CM, estimations of leaf surface chemical composition and morphology in response to heat and drought stress. Preparation, and (macroscopic) characterization, contact angle measurements. Principal investigators:

Victoria Fernandez // v.fernandez@upm.es; Carlos M. Pina // cmpina@geo.ucm.es

Universidad de Valencia and Universidad de Murcia

Nanoscale characterization with particular emphasis on nanoscale roughness and its precise determination using the power spectral density, nanoscale wetting properties, (advanced) Atomic Force Microscopy to measure adhesion and tip-sample interaction. Novel instrumental developments to measure contact angles on living plant surfaces. Modeling of acquired images and multidimensional data sets. High resolution optical microscopy and spectroscopy. Raman Spectroscopy, including confocal and Tip-Enhanced Raman Scattering (TERS). Principal investigators:

Ana Cros Stotter // ana.cros@uv.es and *Jaime Colchero // colchero@um.es*

We are looking for motivated researchers to join the project as PhD students or post-docs with an interest in applied, experimental as well as fundamental research. An advanced level of English and previous knowledge in techniques related to the different fields involved in this interdisciplinary project will be very welcome and valued but are not a strict requirement. Knowledge and expertise in the following fields will be needed along the project: Biology and Plant Science on the one hand, Material Science, Atomic Force Microscopy, wetting on surfaces and Optics/Raman Spectroscopy on the other. We will also value and encourage the willingness to travel and to perform research at the different groups of our project.

If you are interested, send us a CV and we will be happy to discuss any questions and provide additional information.

More technical information about our research proposal: Atomic Force Microscopy (AFM) allows to simultaneously measure the roughness, wetting properties and chemical variations of surfaces on a 5 nm to 100 µm scale. For the case of rose petal surfaces we found an extreme chemical heterogeneity of the upper and lower rose petal surface, with very hydrophilic and very hydrophobic patches being close together. Although the total roughness of the upper and lower side of the Rose Petals is very different (25 µm vs. 3 µm), the contact angle on both surfaces is the same, which proves that rather than total roughness, other parameters -and in particular, the fractal dimension- are relevant for their wetting behavior. Both, extreme roughness and chemical variability were found to be the basis for the Rose Petal Effect (see reference [1]). The idea of our present project is to extend this novel and powerful methodology to other important plant species and model plant surfaces.

In addition to surface characterization by AFM, other microscopic techniques such as optical (OM), transmission (TEM) and scanning (SEM) or confocal microscopy will be used for characterizing model plant surfaces and the effect of climate change stress factors. On the other hand, studies will be performed for estimating the chemical composition of plant surfaces at different scales by Raman Spectroscopy (including confocal and Tip-Enhanced Raman Scattering, TERS) and Fourier transform Infrared Spectroscopy.

At a plant physiological level, experiments will be carried out with field, greenhouse cold frame experiments with pot and field grown model plant species with different surface traits. The effect of climate change stress factors (heat and drought) will be evaluated via physiological and anatomical measurements, prior to developing detailed surface characterization and wettability measurements, as described above.