# Long-term Water Condensation and Collection on Elastic Polymeric Surfaces Under Mild Climatic Conditions

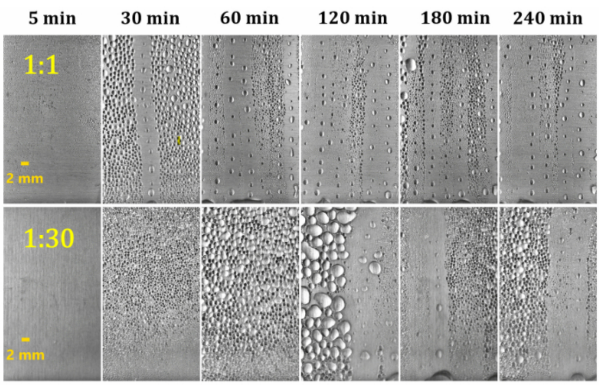
*Sergio Parra Vicente [a] Miguel Cabrerizo Vílchez [a], Francisco Javier Montes Ruiz-Cabello [a] and Miguel Ángel Rodríguez Valverde [a]*

*[a] Laboratory of Surface and Interface Physics (LSIP), Department of Applied Physics, University of Granada, Campus de Fuentenueva, Granada, 18071, Andalucía, Spain*

*fjmontes@ugr.es*

Radiative cooling-based Dew Water Harvesting (DWH) is a promising passive approach for water collection in open-air environments [1]. This strategy leverages thermodynamic principles, wherein condensation results from a temperature gradient between a surface and its surroundings. However, the formation of a liquid layer during condensation creates a thermal barrier, limiting further vapour condensation. Efficient removal and renewal of this layer are critical to enhancing the process. Therefore, polydimethylsiloxane (PDMS) surfaces have emerged as a promising passive strategy for DWH, combining high infrared radiative emissivity with a wettability regime that overcomes the nucleation-density limitations typically associated with hydrophobic surfaces [2].
In this work, the water harvesting performance of a set of PDMS surfaces with tuneable surface properties was investigated by varying the cross-linker-to-base ratio across a wide range of formulations. Long-term condensation experiments were conducted under mild climatic conditions characterised by low subcooling and controlled partial vapour saturation, representative of realistic radiative cooling scenarios. The condensation growth dynamics, droplet shedding behaviour, and the water collection dynamics were monitored simultaneously throughout each experiment.
The results reveal that the water collection rate exhibits a time-dependent behaviour modulated by both the surface properties of the PDMS formulations and the climatic conditions of the system. The total normalised water collected is governed by two interrelated parameters: the onset time of the drainage and collection phase, and the steady-state water collection rate. At experimental durations close to these characteristic timescales, water collecting efficiency was dominated by the surface wetting properties, with clear differences observed between formulations. As experimental duration increased, collection efficiency became controlled by the vapour exchange conditions of the surrounding atmosphere.

**Keywords:**
Condensation, Elastomeric Surfaces, Drop Adhesion, Collection Time, Water Collection Rate




*Front views of the PDMS surfaces 1:1 and 1:30 showing the temporal evolution of the DWH process. Overall, an early condensation stage dominated by nucleation can be distinguished, followed by droplet coalescence, and subsequent removal at later stages of the process.*

**References:**

[1] Beysens, D. (2022). Dew water . River Publishers.
[2] Weng, Y., Zhang, W., Jiang, Y., Zhao, W., & Deng, Y. (2021). Effective daytime radiative cooling via a template method based PDMS sponge emitter with synergistic thermo-optical activity. Solar Energy Materials and Solar Cells , 230 , 111205.

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