

Mathematical model of dropwise condensation on textured surfaces

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Introduction

The aim of this project is to develop a geometric and mathematical model for simulating dropwise condensation in order to control the rate of droplets growth on a textured surface. Comparison between gray-scale images taken from droplets growing on pillared and flat surfaces shows considerable differences between these two processes. Most importantly, since the droplets can be easily canalized between the texture patterns, the shape of droplets usually changes from spherical to ellipsoidal specially in later stages.

The novel model proposed here calculates the growth rate of ellipsoidal droplets during adsorption and coalescence steps on pillared substrates. The first step is to position the pillars as cylinders with the specified diameter and height. Then, the random ellipses with their densities issued from the experimental procedure are distributed on the 3-dimensional pillared substrate. Since on a textured surface the droplets can be located at different positions with respect to texturations, there will be a 3-D configuration of droplets that can coalesce in all the directions of X, Y, or Z.

The results of this model can be validated by comparison with the results obtained from gray-scale images during the experimental process. In this regard a different image binarization method that enables to detect droplets from the pillars is applied to the gray scale images. The problem with recognizing droplets on the pillared substrates is that droplets are very similar to the pillars (both of them are circular with darker boundaries and brighter centers) or some droplets cover several pillars at the same time.

Results and conclusion

The results of the simulation model is compared with real data from 6 different configurations of pillars and the mean error of the model is calculated equal to $2.28 \pm 0.42\%$.

Acknowledgments

The authors would like to thank Nicolas Pionnier for the experimental results obtained during his PhD funded by PSA Peugeot-Citroen in the context of OpenLab VAT@Lyon between Peugeot-Citroen and LTDS laboratory. This work was funded by LABEX MANUTECH-SISE (ANR-10-LABX-0075, within the program "Investissements d'Avenir" (ANR-11-IDEX-0007) operated by the French National Research Agency (ANR).