ICCES, 2023, vol.27, no.4

Tech Science Press

DOI: 10.32604/icces.2023.09327

PROCEEDINGS

Dissolution at a Meniscus-Adhered Nanofiber

Shihao Tian[1,2] and Quanzi Yuan[1,2,*]

[1] State Key Laboratory of Nonlinear Mechanics, Institute of Mechanics, Chinese Academy of Sciences, Beijing, 100190, China

[2] School of Engineering Science, University of Chinese Academy of Sciences, Beijing, 100049, China

[*]Corresponding Author: Quanzi Yuan. Email: yuanquanzi@lnm.imech.ac.cn

ABSTRACT

When one soluble fiber is partially merged into liquid, a meniscus forms and the fiber can be dissolved into one pinpoint with curvature. This process has been used in the manufacture of sophisticated pinpoints. However, it is hard to observe the dissolution process in the laboratory and the dissolution mechanisms are still far from being well understood in the nanoscale. Here we utilize molecular dynamics simulations to study the dissolution process of one meniscus-adhered nanofiber. We find that the tip's curvature radius decreases and then increases, reaching the maximum in the middle state. This state is defined as the "Sh (Sharpest) point", which can be used as the termination criterion in applications. What's more, the shape of the pinpoints can be well fitted to the double-Boltzmann function. The upper part is caused by the competition between the chemical potential gradient and molecular forces, while the lower part is controlled by the Cahn-Hilliard equation. The parameters of the double-Boltzmann function have a strong correlation with the width and the material of the nanofiber, where the critical width value is around 125 Å. Furthermore, a shape factor, Sh, allows characterizing the sharpness of the dissolved pinpoints. Finally, the dissolved pinpoints are proved to have the characteristic of shielding capillary effects compared with the normal pinpoints based on theory and simulations. Our findings may help to comprehend the dissolution process of meniscus-adhered nanofiber and provide theoretical support for nano-instrument manufacture.

KEYWORDS

Dissolution; double-Boltzmann function; molecular dynamics simulations; size effects; capillary effects

Acknowledgement: The authors would like to thank Prof. Yuan for writing review, editing, supervision, project administration, and funding acquisition. The authors gratefully acknowledge the support of the National Natural Science Foundation of China (NSFC, Grant No. 12072346), and the Open Fund of Key Laboratory for Intelligent Nano Materials and Devices of the Ministry of Education NJ2022002 (INMD-2022M01).

Funding Statement: This work was jointly supported by the National Natural Science Foundation of China (NSFC, Grant No. 12072346), and the Open Fund of Key Laboratory for Intelligent Nano Materials and Devices of the Ministry of Education NJ2022002 (INMD-2022M01).

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.