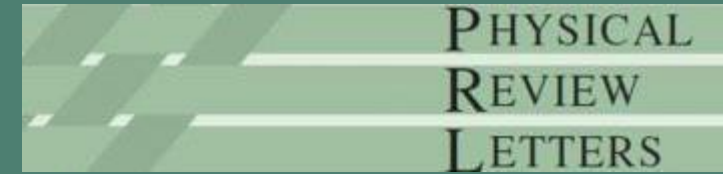


PRL



Origin of the Sharkskin Instability: Nonlinear Dynamics

Numerical simulations reveals the intrinsic mechanism for the onset of the sharkskin instability in polymer extrusion process

In this paper, we have studied polymer extrusion, an important process in plastics manufacturing. Often the final material's surface is rough with semi regular grooves resembling the skin of a shark. This phenomenon, known as sharkskin instability, has intrigued the scientific and industrial communities for over 60 years. We have reported the results of a simple physical model which explains the underlying mechanism that causes the sharkskin instability. We simulated the flow of polymer melts being squeezed through a slit and observed that the stretched polymer chains are stretched toward the exit, then recoiled as they moved further away, causing a swell and forming waves. These waves became the familiar sharkskin grooves on the surface of the melt.

The Fluids Lab, Department of Chemical Engineering, University of Patras



A recent Publication in PRL

Phys. Rev. Lett. 127, 088001

[Vol. 127, Iss. 8 — 20 August 2021](#)

DOI:
[10.1103/PhysRevLett.127.088001](https://doi.org/10.1103/PhysRevLett.127.088001)

Published By: American Physical Society

Impact Factor: **9.161**

The screenshot shows the article page for "Origin of the Sharkskin Instability: Nonlinear Dynamics" in Physical Review Letters. The page features a dark green header with the journal title and navigation links. Below the header, there are tabs for "Featured in Physics" and "Open Access". The article title and authors (Stylianos Varchanis, Dionisis Pettas, Yannis Dimakopoulos, and John Tsamopoulos) are displayed, along with the publication date (17 August 2021). A "PhysiCS" logo and a "See synopsis" link are also present. On the right side, there is a circular badge with the number "29" and social media sharing icons for Twitter, Facebook, and a "More" option. Below the article information, there are buttons for "Article", "References", "No Citing Articles", "Supplemental Material", "PDF", "HTML", and "Export Citation". The main content area includes an "ABSTRACT" section with a detailed description of the research, three small images, and a "Check for updates" button. At the bottom, there is a "Reuse & Permissions" button and a "PRX ENERGY" logo. The page also displays the article's reception history (Received 9 March 2021, Revised 25 May 2021, Accepted 30 June 2021) and the DOI link.

Picked up by 2 news outlets

The screenshot shows the APS Physics website interface. At the top, there are navigation tabs for 'Journals', 'Physics Magazine', 'PhysicsCentral', and 'APS News'. Below this is a purple header with the 'Physics' logo and navigation links: 'ABOUT', 'BROWSE', 'PRESS', 'COLLECTIONS', and a search bar. The main content area features the article title 'Analyzing the Sharkskin Instability' in a large, bold font. Below the title is the date 'August 17, 2021' and the journal information 'Physics 14, s106'. A short abstract follows: 'The stretching and recoiling of polymer chains leads to the characteristic ridge pattern as a soft material exits a narrow nozzle.' Below the abstract is a 3D visualization of a polymer melt surface with a yellow-to-green color gradient and a grid pattern. To the right of the article, there are social media sharing icons (PDF Version, Facebook, Twitter, etc.) and a 'Synopsis' section. Below the synopsis, there are two 'Recent Articles' sections: 'Origin of the Sharkskin Instability: Nonlinear Dynamics' and 'When Liquid Droplets Take a Turn'. The bottom of the page has a 'More Recent Articles' link.

Journals | Physics Magazine | PhysicsCentral | APS News

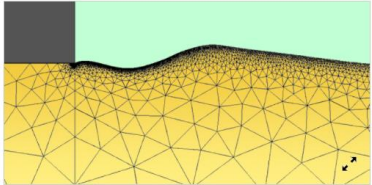
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SYNOPSIS

Analyzing the Sharkskin Instability

August 17, 2021 • Physics 14, s106

The stretching and recoiling of polymer chains leads to the characteristic ridge pattern as a soft material exits a narrow nozzle.



S. Varchanis et al. [1]

When a polymer melt squeezes through a small nozzle—a process common to all plastics manufacturing—the extruded material's surface becomes roughened because of a phenomenon known as the sharkskin instability. The polymer-processing community has long known that these scaly ridges are caused by large tensile stresses in the melt near the nozzle, but simulations have so far failed to capture the underlying physical mechanism in detail. Stylianos Varchanis of the University of Patras, Greece, and his colleagues now report a simple physical model that reproduces the flow's transition from smooth to scaly [1].

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Origin of the Sharkskin Instability: Nonlinear Dynamics
Stylianos Varchanis, Dionisis Pettas, Yannis Dimakopoulos, and John Tsamopoulos
Phys. Rev. Lett. 127, 088001 (2021)
Published August 17, 2021

Recent Articles

When Liquid Droplets Take a Turn
A new model reveals that patterns of internal fluid flow control whether self-propelling water droplets in oil follow linear or curved trajectories.

Visualizing Microscopic 3D Displacements of Things over Large Areas
Researchers demonstrate a technique that can track displacements as small as 10 nm with a sensitivity that is independent of field-of-view.

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A new model of light-matter interactions solves a decades-old problem by reconciling theoretical predictions and experimental observations of polarized light from the Sun.

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The screenshot shows the Chinese Physical Society Journals website interface. At the top, there is a blue header with the website name '中国物理学会期刊网' and 'Chinese Physical Society Journals'. Below this is a navigation bar with links: '首页', '期刊', '新闻', '专题', '图书', '科普', '讲座', '会议', '视频', '专利', '专家', '服务'. There is also a search bar and a '登录' button. The main content area features the article title 'Analyzing the Sharkskin Instability' in a large, bold font. Below the title is the date '2021-08-16' and the source '来源: American Physical Society Sites'. A short abstract follows: 'The stretching and recoiling of polymer chains leads to the characteristic ridge pattern as a soft material exits a narrow nozzle.' Below the abstract is a 3D visualization of a polymer melt surface with a yellow-to-green color gradient and a grid pattern. To the right of the article, there are social media sharing icons and a '热点聚焦' section with a list of related articles. Below the list, there is a '优秀专题' section with a featured article '机器学习与物理' and a '视频' section with a featured video.

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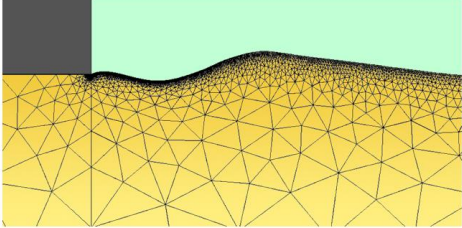
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Analyzing the Sharkskin Instability

2021-08-16 来源: American Physical Society Sites
来源地址: <https://physics.aps.org/articles/v14/s106>

分享到

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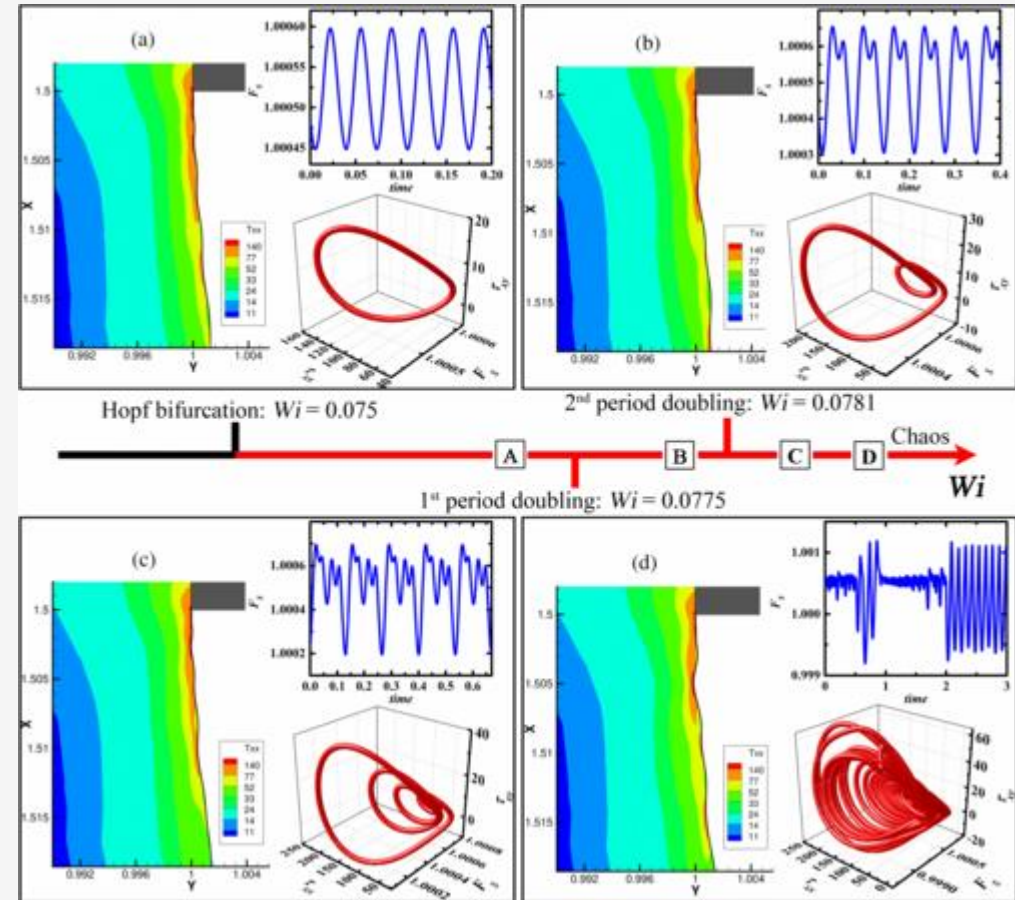
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Full Story

The appearance of surface distortions on polymer melt extrudates, often referred to as sharkskin instability, is a long-standing problem. We report results of a simple physical model, which link the inception of surface defects with intense stretch of polymer chains and subsequent recoil at the region where the melt detaches from the solid wall of the die. The transition from smooth to wavy extrudate is attributed to a Hopf bifurcation, followed by a sequence of period doubling bifurcations, which eventually lead to elastic turbulence under creeping flow. The predicted flow profiles exhibit all the characteristics of the experimentally observed surface defects during polymer melt extrusion.



The route to elastic turbulence

Links

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