Wetting Between Parallel Fibres;  
Column-Unduloid and Column Disintegration Transitions

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OVERVIEW OF THE PRESENTATION
I. Introduction
II. Morphological transitions of a wetting phase on three parallel fibres
III. Analytical description
IV. Computer simulation
V. Experimental
VI. Conclusion
I. INTRODUCTION

• Wetting of structured substrates exhibits unusual features.
II. Introduction

• New Finding:
• wetting phases undergo abrupt changes in shape on structured substrates.

• P. Lenz, R. Lipowski, 1997
II. MORPHOLOGICAL TRANSITIONS OF THE WETTING PHASE ON THREE PARALLEL FIBRES

- Column-disintegration transition
- H.M. Princen
- 1970
II. Morphological ...

- Column-unduloid transition

\[
d/b_{tr2} = 2.85337
\]
III. ANALYTICAL DESCRIPTION

\[
\left( \frac{b}{R} \right)_D = \frac{r' + 2\pi}{-r' + \sqrt{-2\pi r'}}
\]

\[
r' = 4 \cdot \sin \alpha \cdot \cos \alpha - 4\alpha
\]

\[
F_S(\gamma_S) \quad \text{column-disintegration} \quad F_{SL}(\gamma_{SL}) \quad F_L(\gamma) \quad F_P(\gamma_P)
\]

\[
F_S = F_{SL} + F_L + F_P
\]

\[
\Theta = 0^\circ
\]

\[
\left( \frac{b}{R} \right)_C = \frac{r + 2\pi}{-r + \sqrt{-2\pi r}}
\]

\[
r = \sqrt{3 \cos^2 \alpha - \frac{\pi}{2}} + 3 \sin \alpha \cdot \cos \alpha - 3\alpha
\]

\[
R' = R
\]

\[
r' = r
\]

\[
(d/b)_{tr} = 0.07869
\]

\[
\Theta = 0^\circ
\]

\[
\alpha = 2d
\]

\[
b
\]
III. Analytical description
III. Analytical description

column-unduloid

\[ F_p + F_s = F_{SL} + F_L \]

\[ \pi (R^2 - 3b^2) \frac{\gamma}{R} + 6\pi b \gamma_S = 6\pi b \gamma_{SL} + 2\pi R \gamma \]

\[ \gamma_S = \gamma + \gamma_{SL} \]

\[ \Theta = 0^\circ \]

\[ \frac{R}{b} \]

\[ d/b = f(R/b) \]

\[ d/b_{tr2} = 2.85337 \]
III. Analytical description

\[(d/b)_{tr1} = f(\Theta)\]
III. Analytical description
III. Analytical description
IV. COMPUTER SIMULATION

Monte Carlo Method, Ising Model

\[ t_1 \rightarrow t_2 \rightarrow t_3 \rightarrow t_4 \]

\[ E(t_1) = \sum_{ij} E_{ij} \]

\[ E_{(LL)} \]

\[ E_{(kl)} \]
IV. Computer simulation

\[ W_{s \rightarrow s+1} = \begin{cases} e^{-\frac{E_{s+1} - E_s}{kT}} & \text{if } E_{s+1} > E_s \\ 1 & \text{if } E_{s+1} \leq E_s \end{cases} \]
IV. Computer simulation

\[ \frac{d}{b} = 0.05 \]

\[ \frac{d}{b} = 0.1 \]

\[ \left( \frac{d}{b} \right)_{tr1} = 0.07869 \]
IV. Computer simulation

$t=1$

$t=300$

$t=700$

$d/b_{\text{tr}2} = 2.85337$

$d/b = 1.00$
IV. Computer simulation

\[
d/b_{tr2} = 2.85337
\]

\[
d/b = 3.64
\]
V. EXPERIMENTAL

$\Theta = 40^\circ$
V. Experimental

d/b = 0.11
V. Experimental

d/b = 0.11
VI. CONCLUSION
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