Polyolefin Plastics

Still a challenge for Chemical Engineers?

R. J. Koopmans

Corporate R&D

Dow Benelux BV

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Polyolefin Plastics

at does it take to make it

lications

cessing

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What does it take to make Plastics?

tics

n ensemble of polymers and other organic and/or organic components

mers

n ensemble of macromolecules of equal chemical mposition but of different molecular mass

romolecules

n ensemble of large molecules of same chemical mposition and molecular mass

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What does it take to make Plastics?

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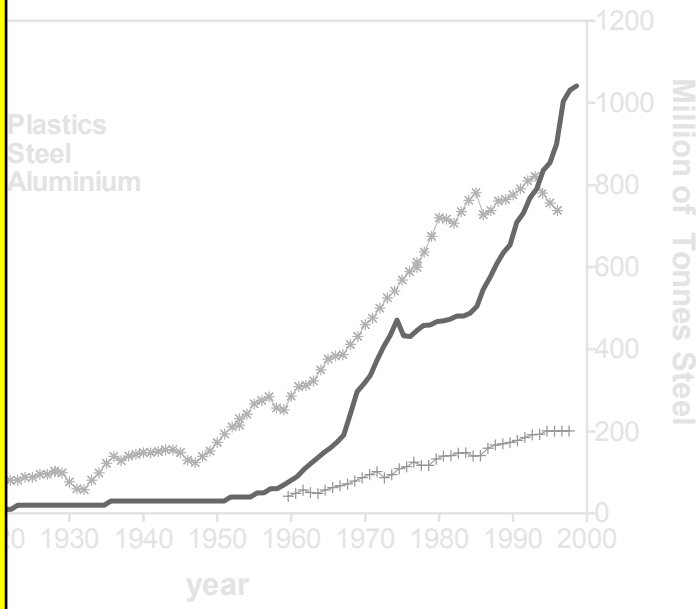
What does it take to make Plastics?

Plastics Industry



- Western Europe
  - 1.1 mm employed
  - 135 billion Euro
  - 45 Global Companies
  - 30,000 SME
- World
  - > 120 mm T
  - 5% average growth

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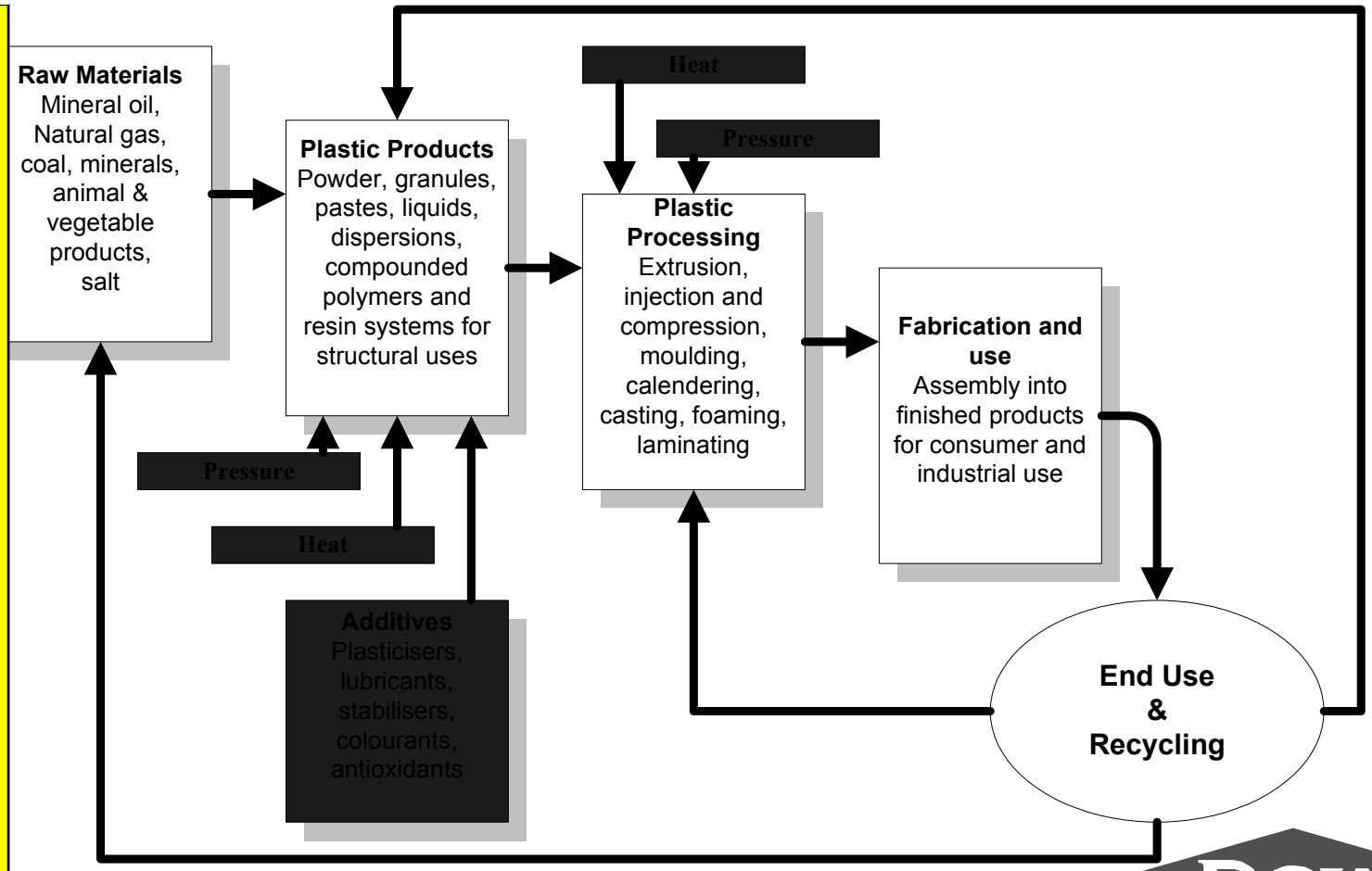
What does it take to make Plastics?



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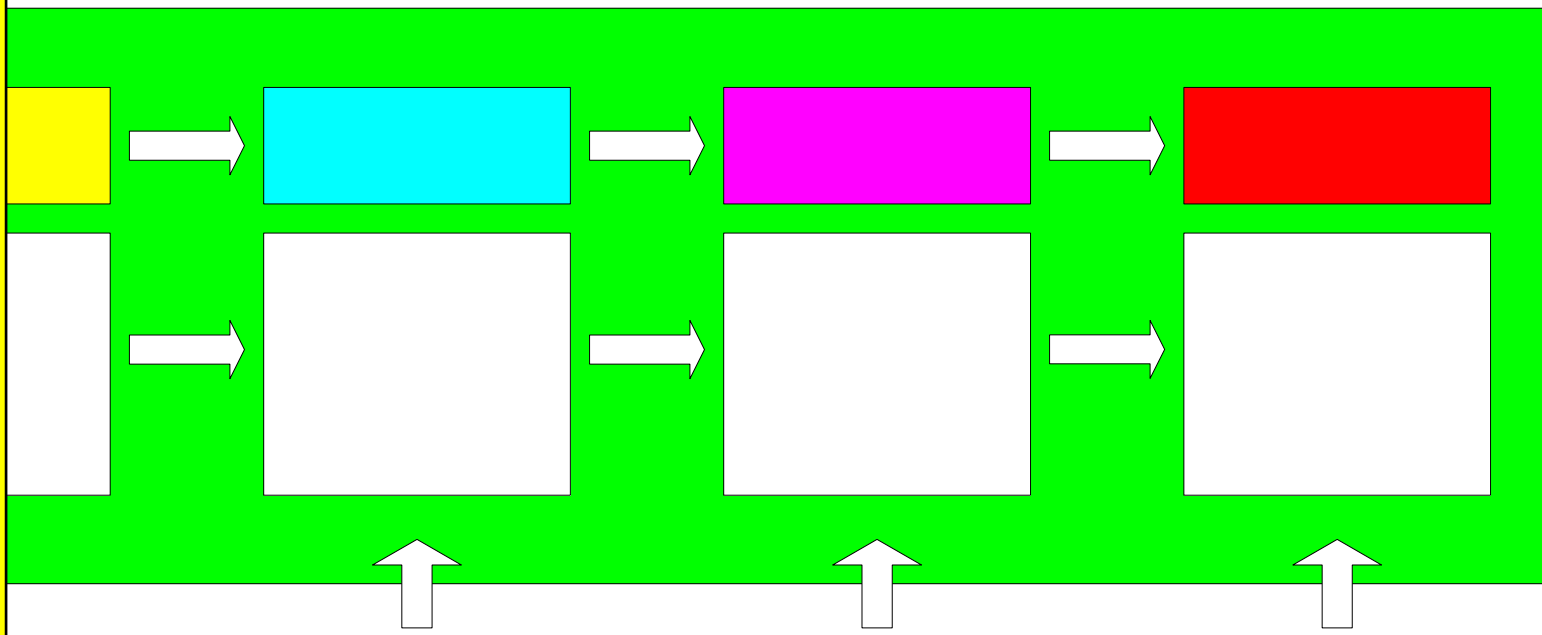
What does it take to make Plastics?



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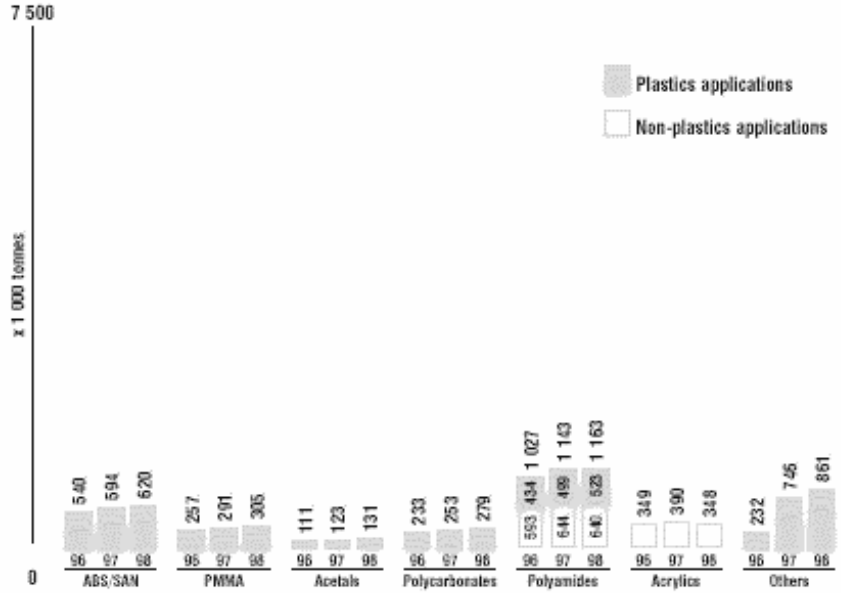
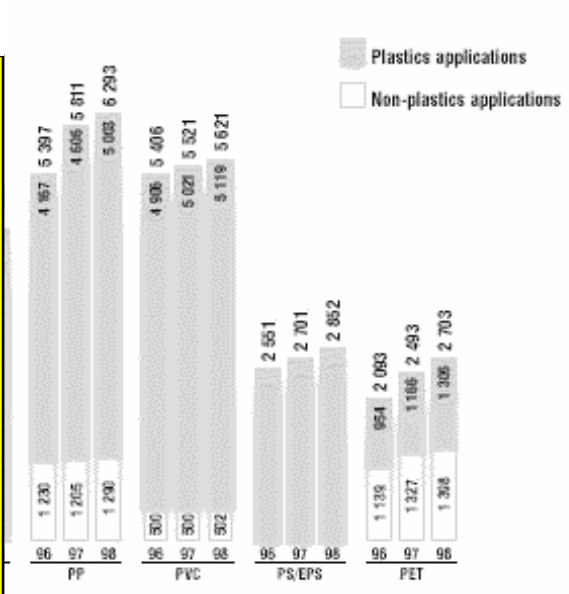
Plastics Applications & Use by Sectors in Europe





- noplastics
- mmodity plastics
- ngineering plastics
- osets

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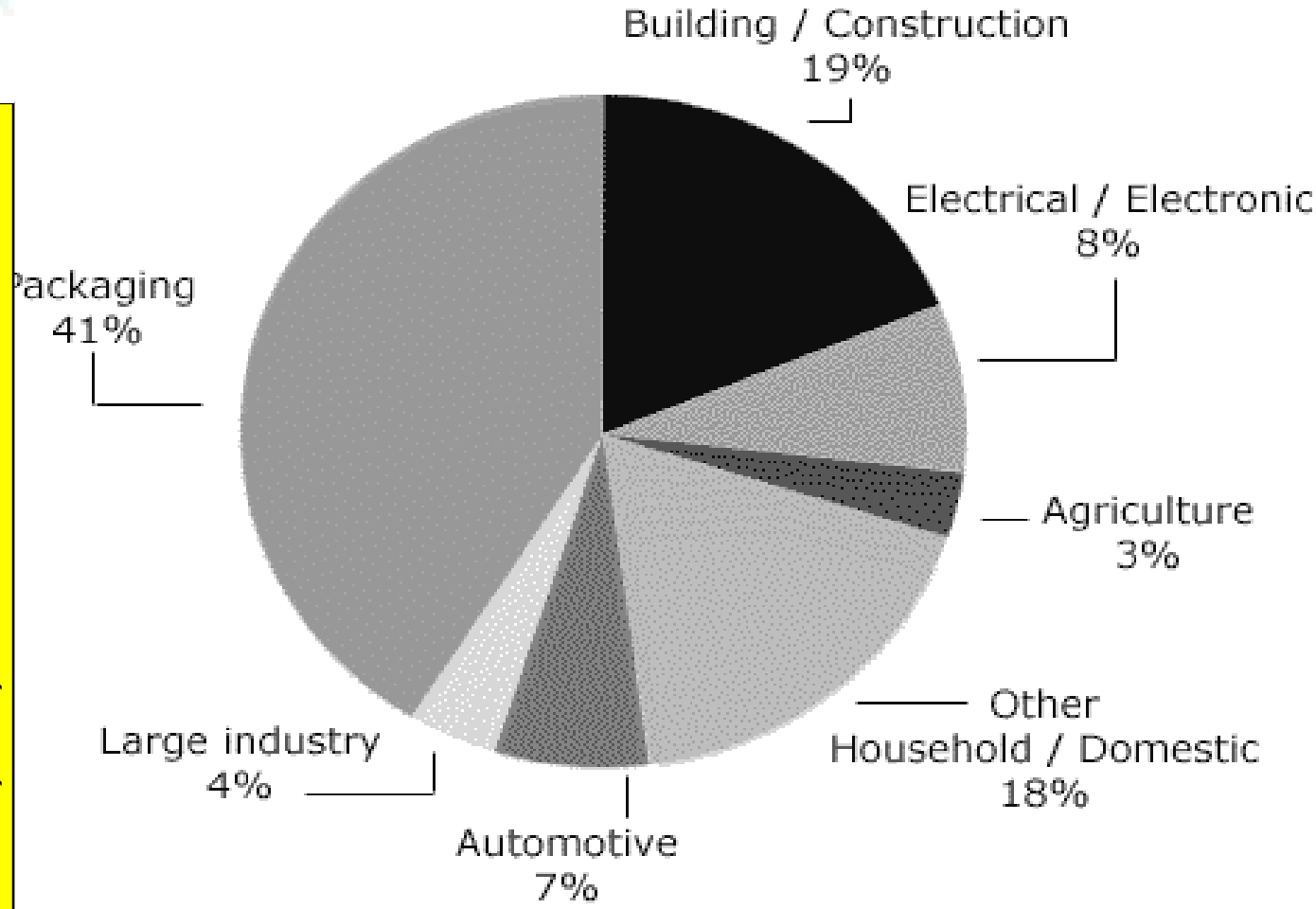

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Application Performance

- y Cost
- nt Weight
- ugh
- y processing
- tainable – recyclable

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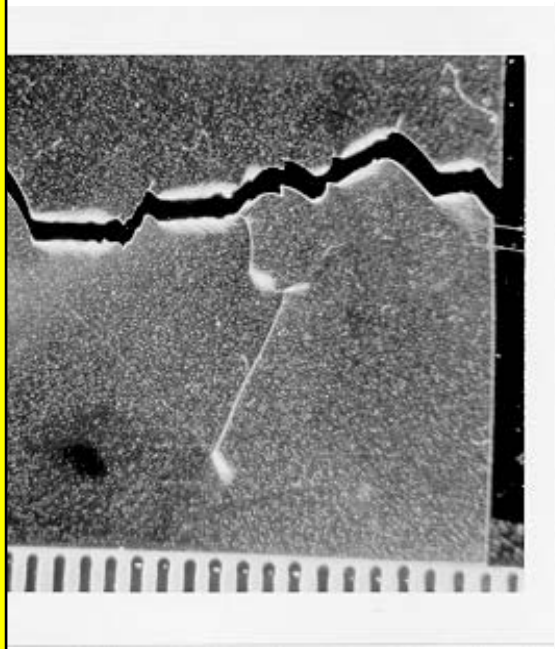
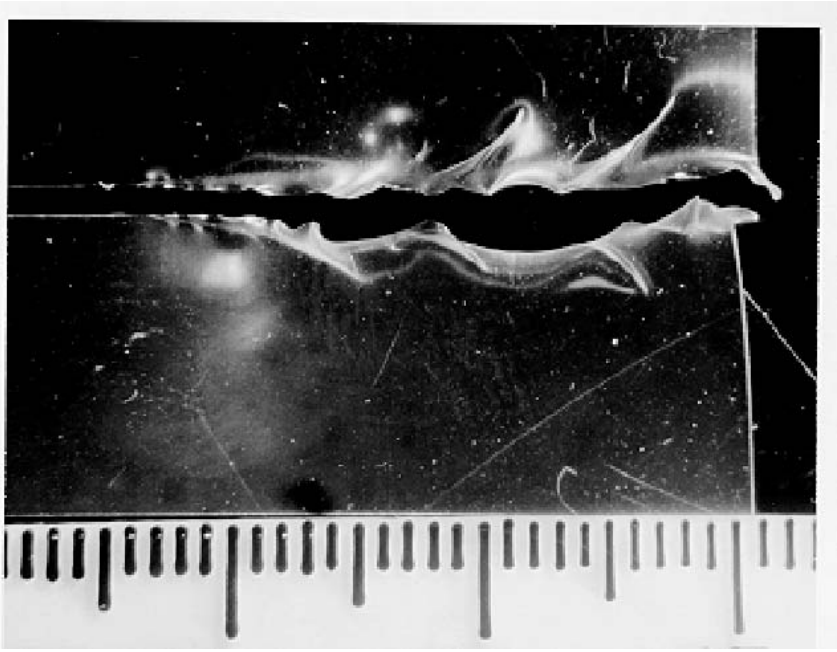
Applications: Brittle and Ductile failure



Brittle tear



Ductile tear

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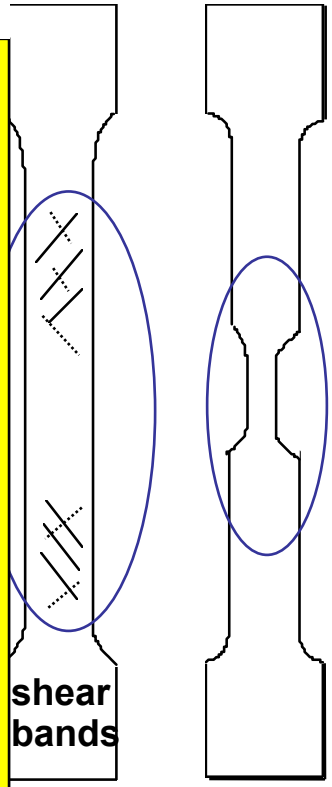
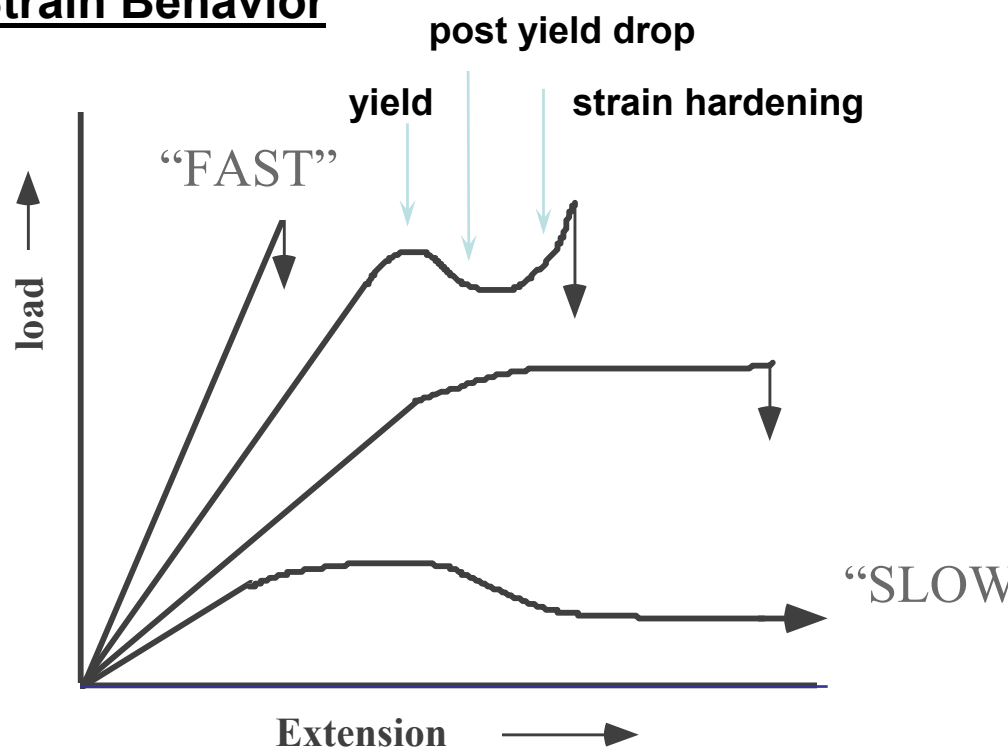
Applications: Tensile Testing

Stress Strain Behavior



localized
neck



Consider temperature also

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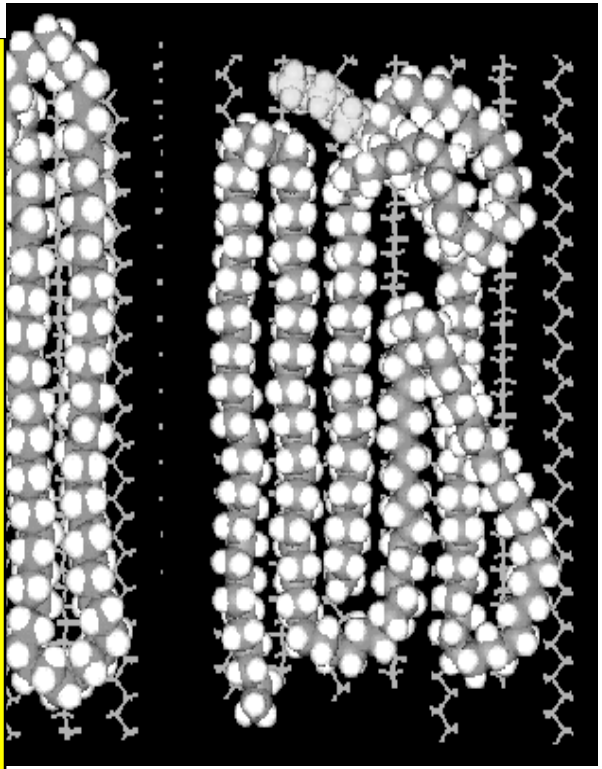
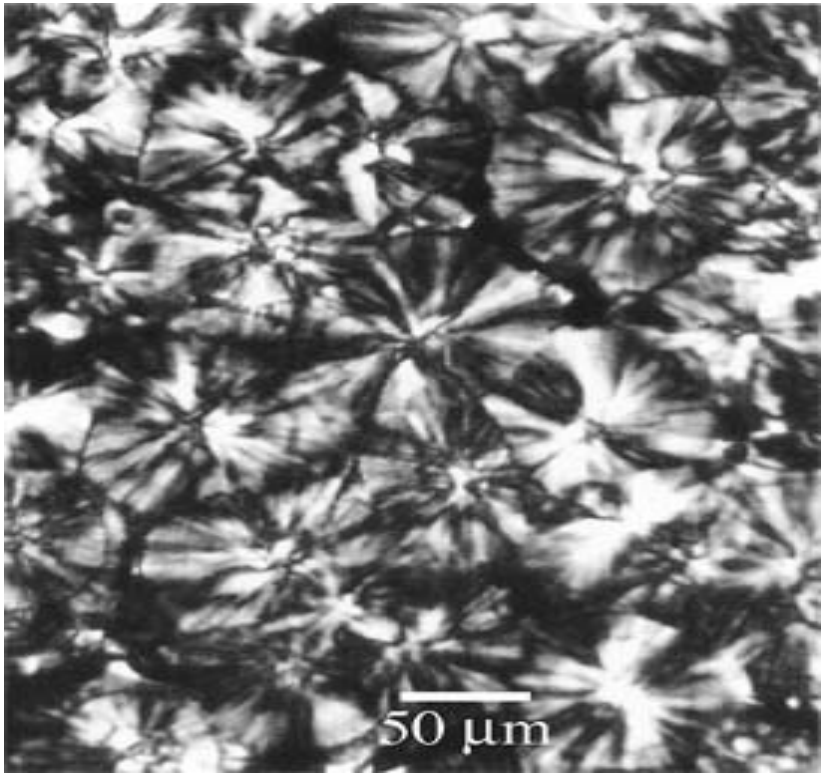
Applications: Crystallisation





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:rusion Blown Film Application

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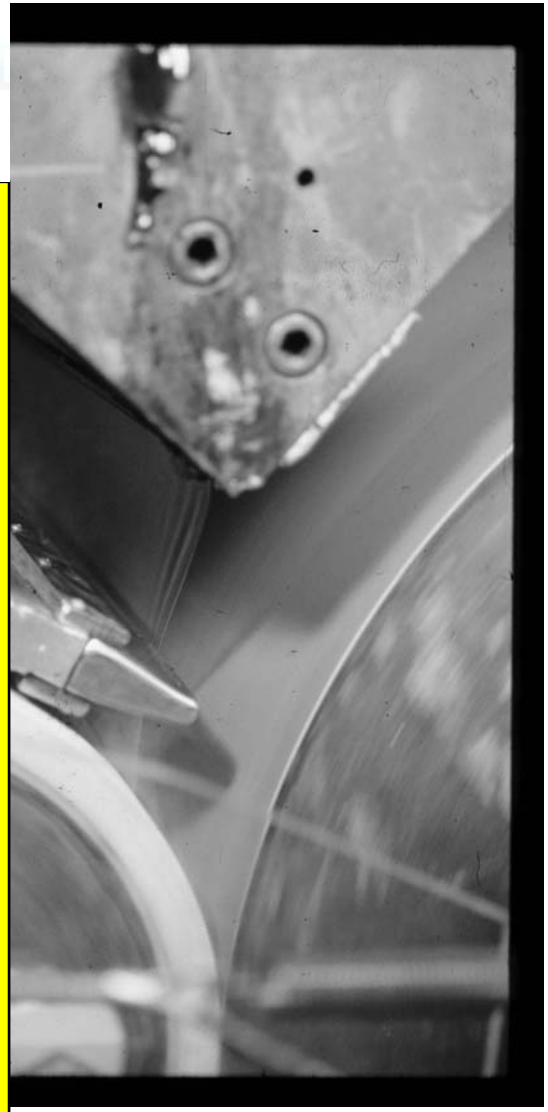
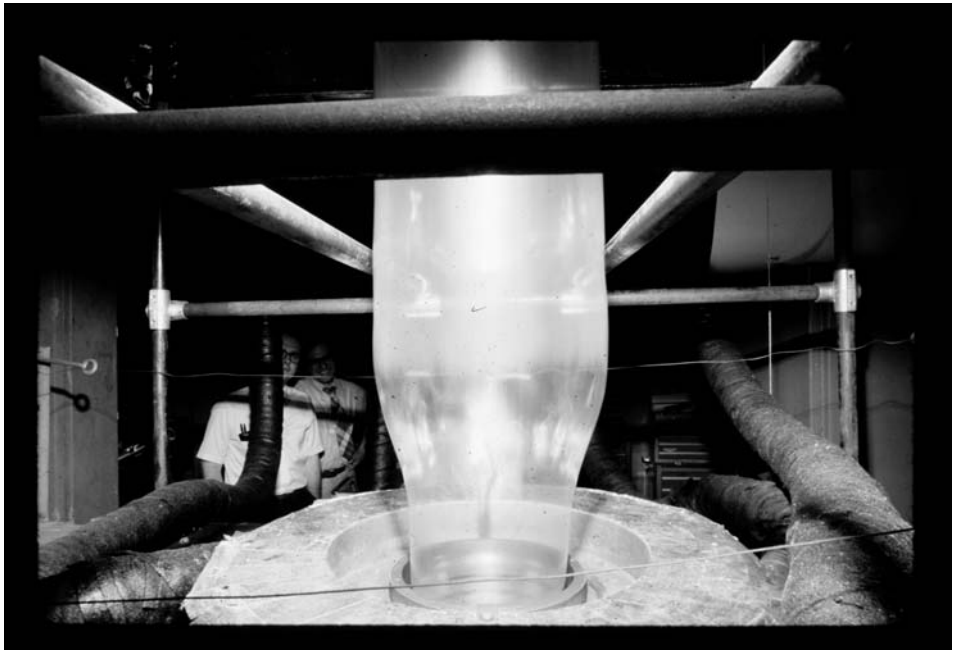
Processing





Processing of Film:
Extrusion Casting process
Extrusion Blowing process

Output driven

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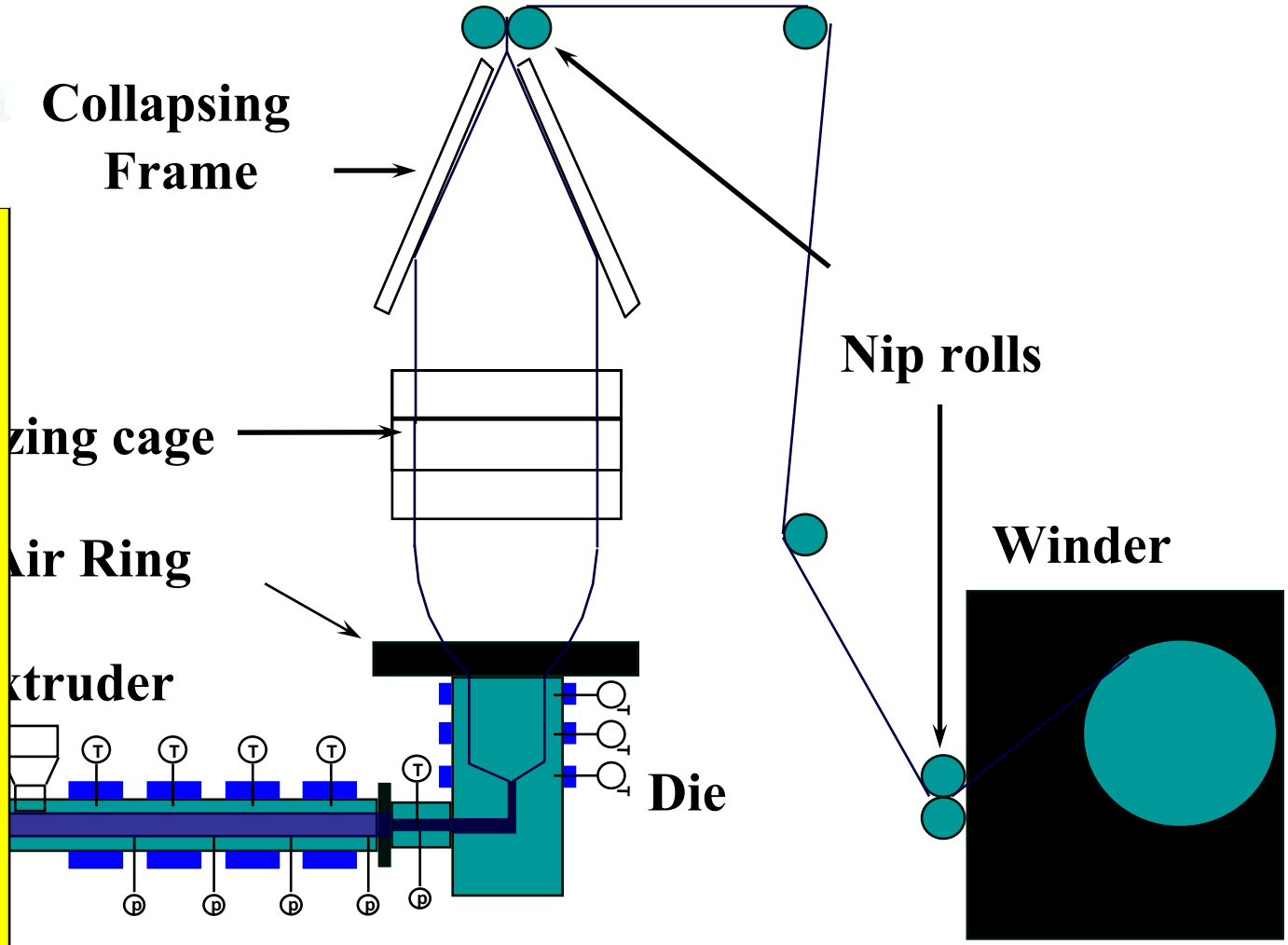
xtrusion Blown Film Process



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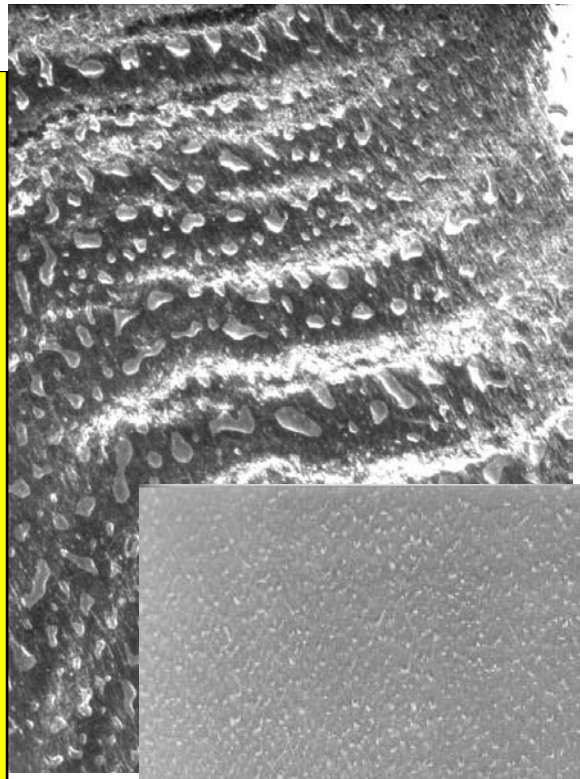
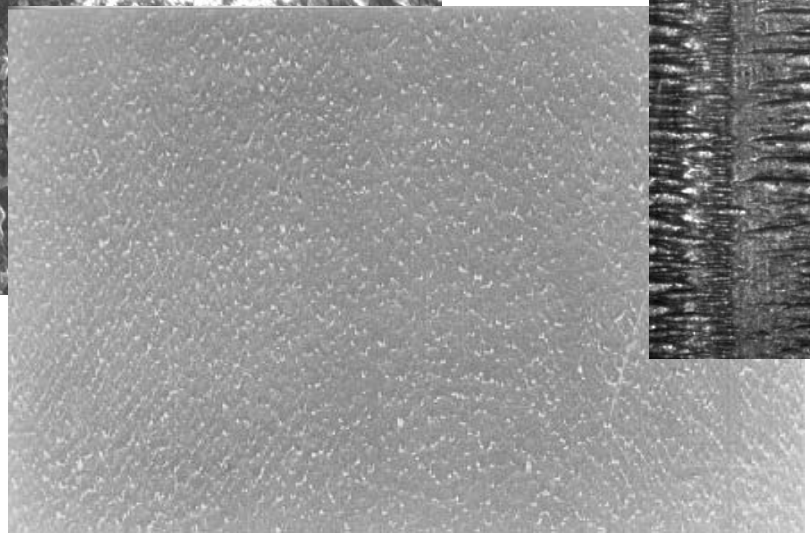
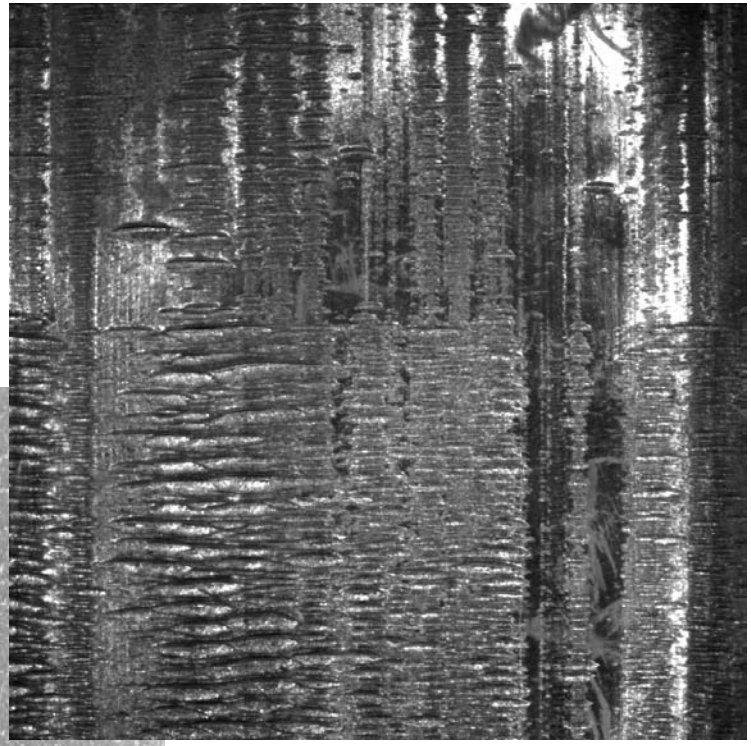
Processing Challenges

Film distortions come in many shapes







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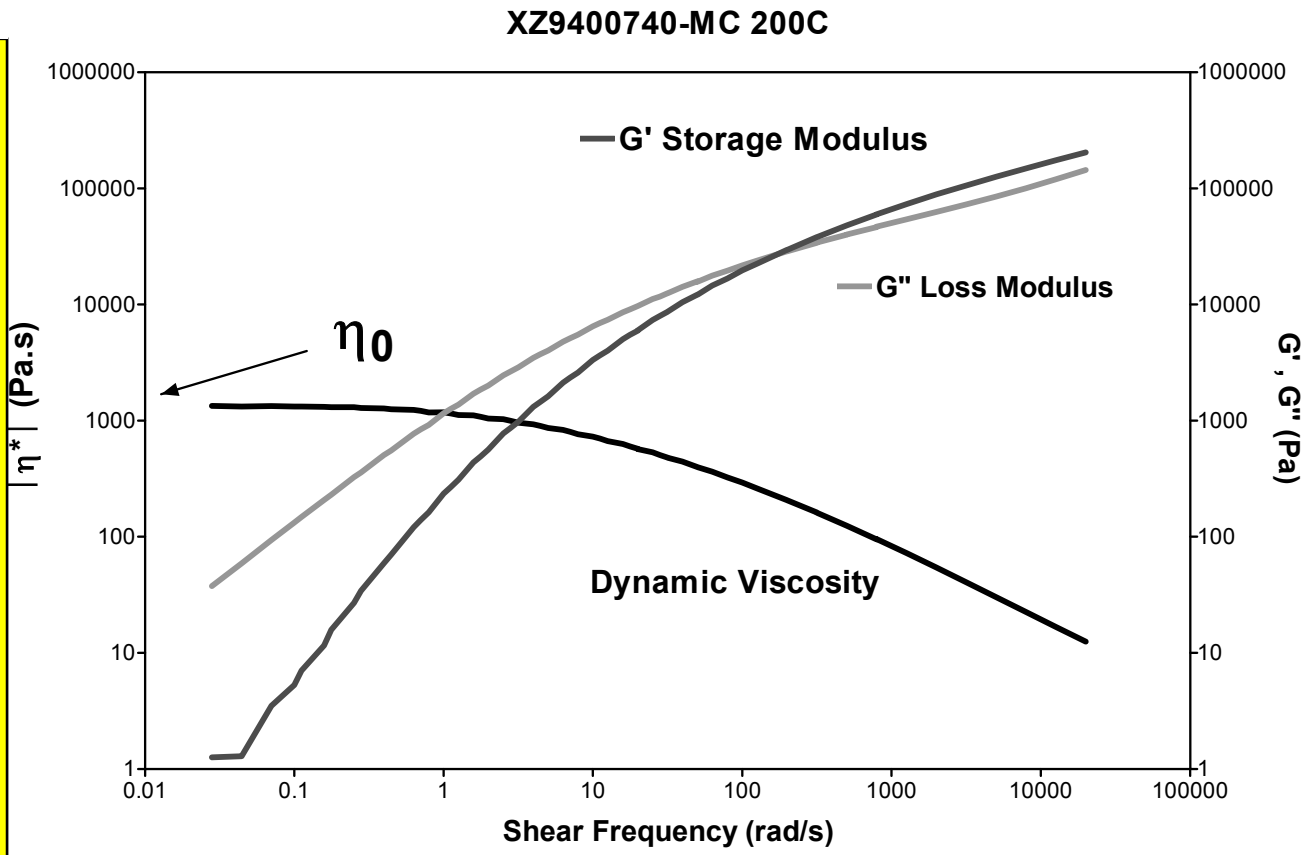
Melt Flow Instabilities



η_0 key metric of the flow curve

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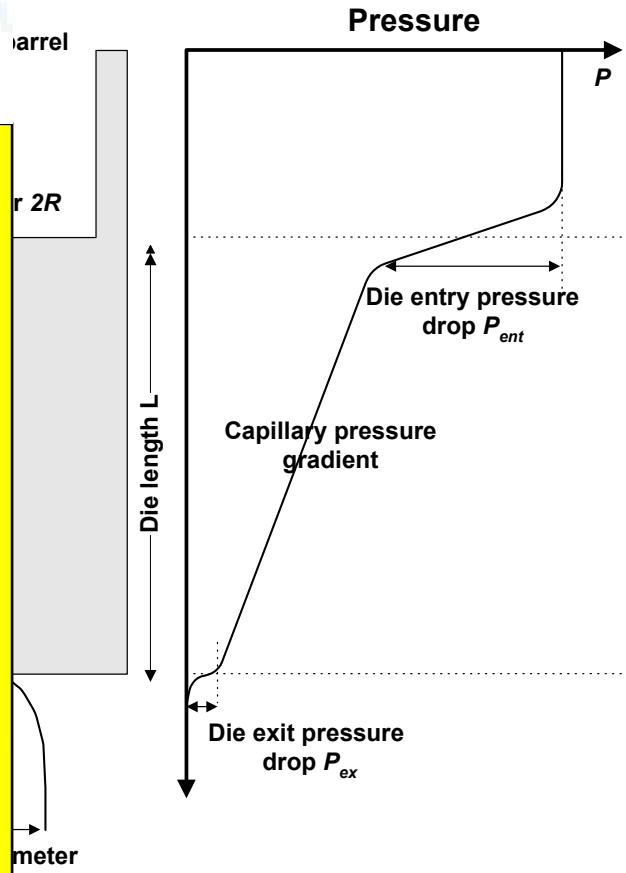
Capillary Rheometer



Shear Viscosity Only !

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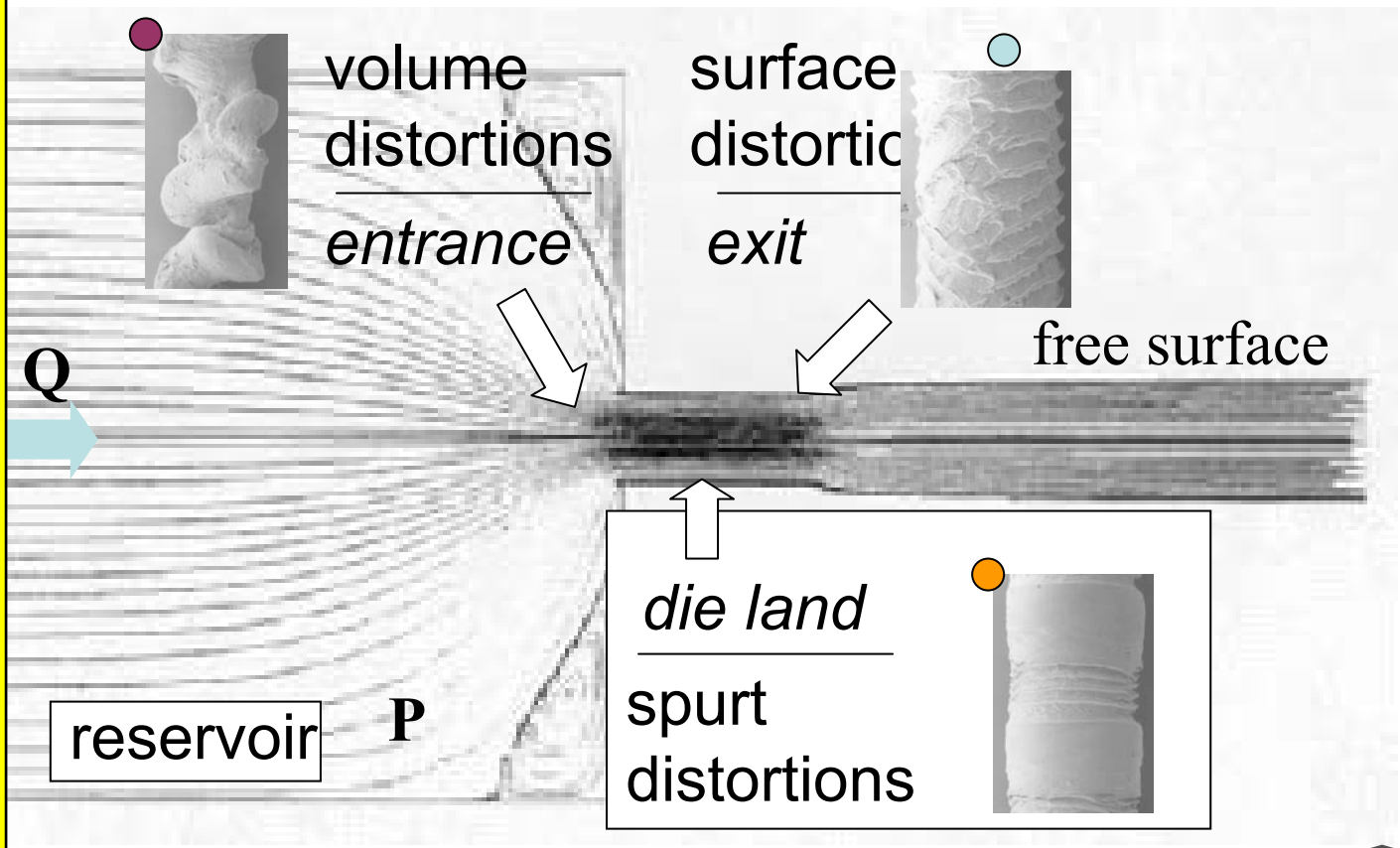
Melt Flow Instabilities

amples: LLDPE, HDPE, PP, PS

all distortion types



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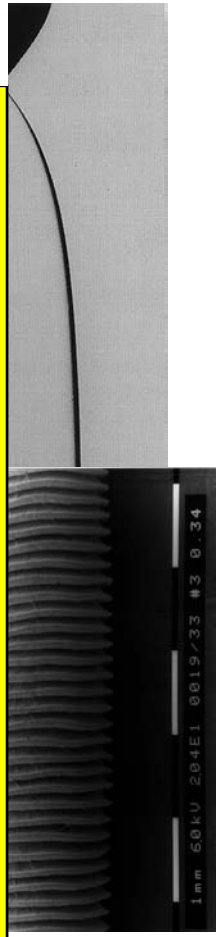
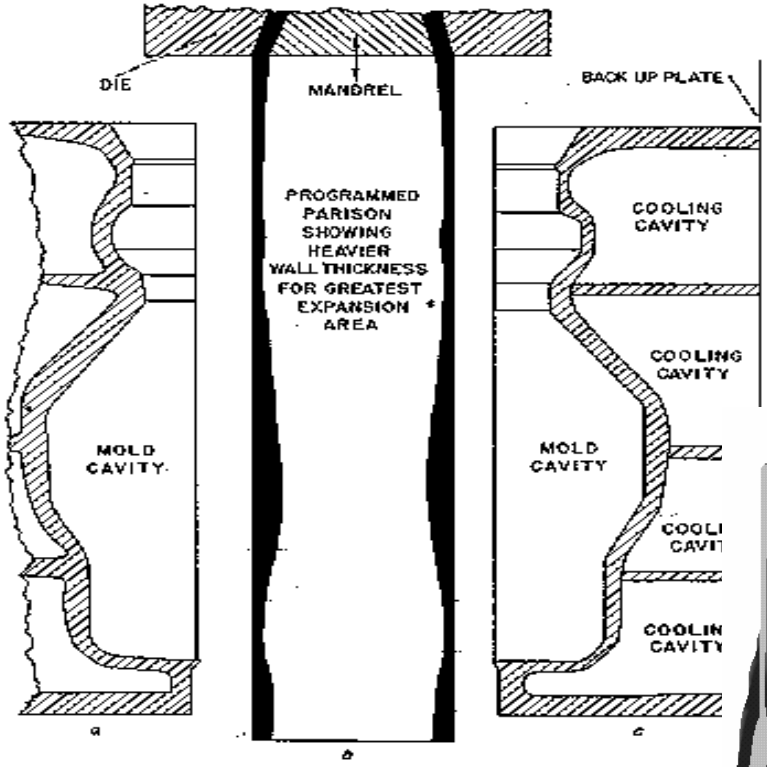
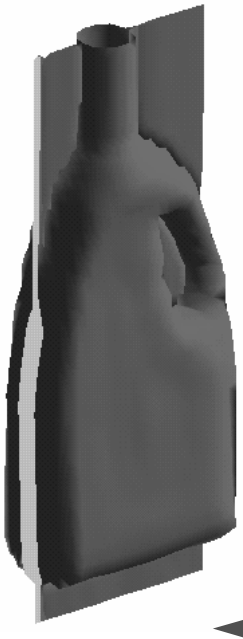
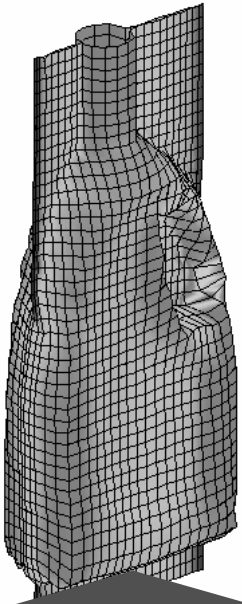
Extrusion Blow Molding of Bottles





A programmed parison designed to fit a particular mold configuration.





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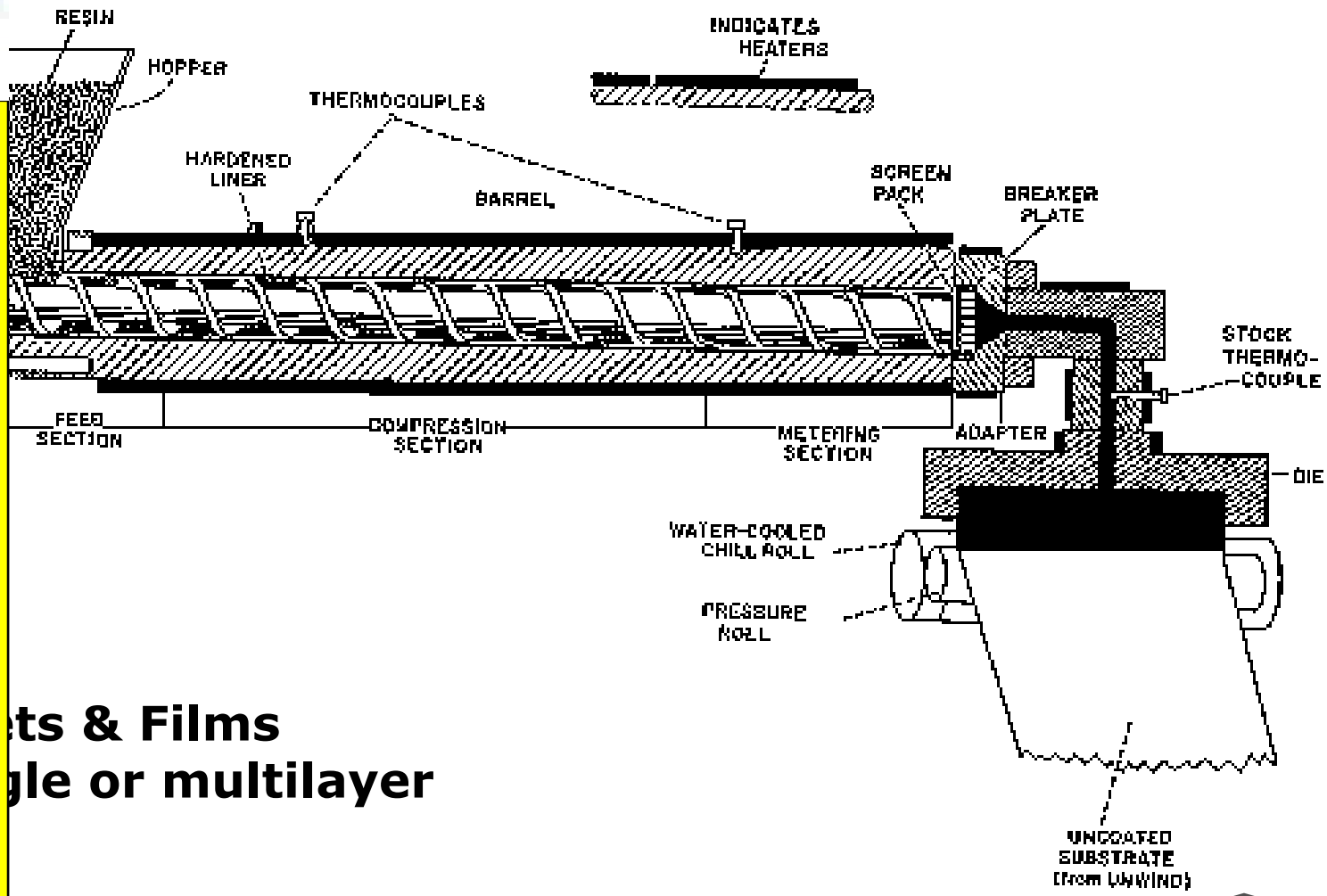
Cast Extrusion



ts & Films
gle or multilayer

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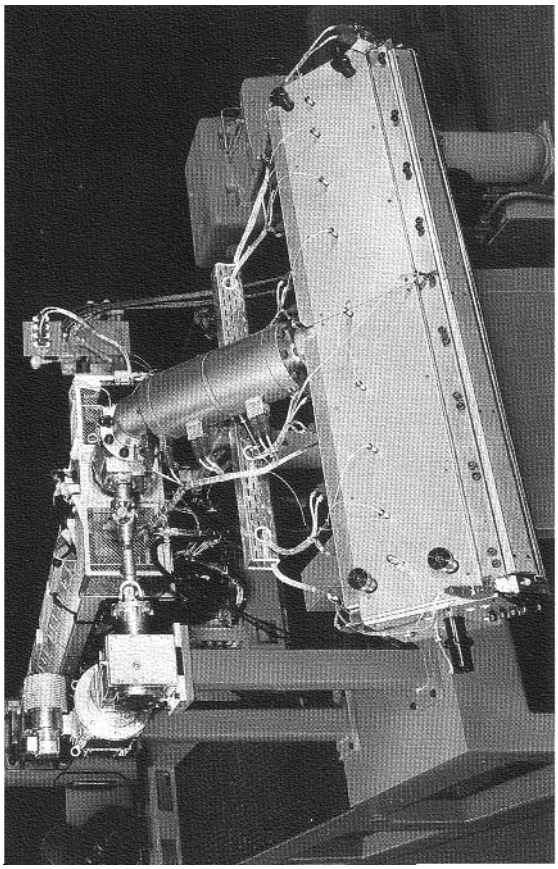
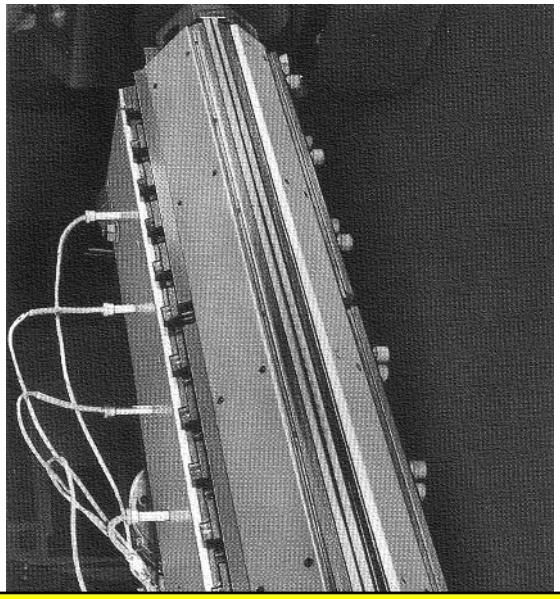
Cast Sheet Extrusion





DOW

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Cast Extrusion

potheses:

tion

$$\dot{\varepsilon} = \begin{bmatrix} \frac{du}{dx} & 0 & 0 \\ 0 & f(x) & 0 \\ 0 & 0 & g(x) \end{bmatrix}$$

Membrane approximation ($\sigma.\mathbf{e}_z \sim 0$)

$$u(x); v(x,y) = y.f(x); w(x,z) = z.g(x)$$

tion: $$\frac{\partial(eL)}{\partial t} + \frac{\partial(eLu)}{\partial x} = 0$$

um: $$div(\mathbf{e}.\sigma) = \mathbf{0}$$

ace tension << drawing force)

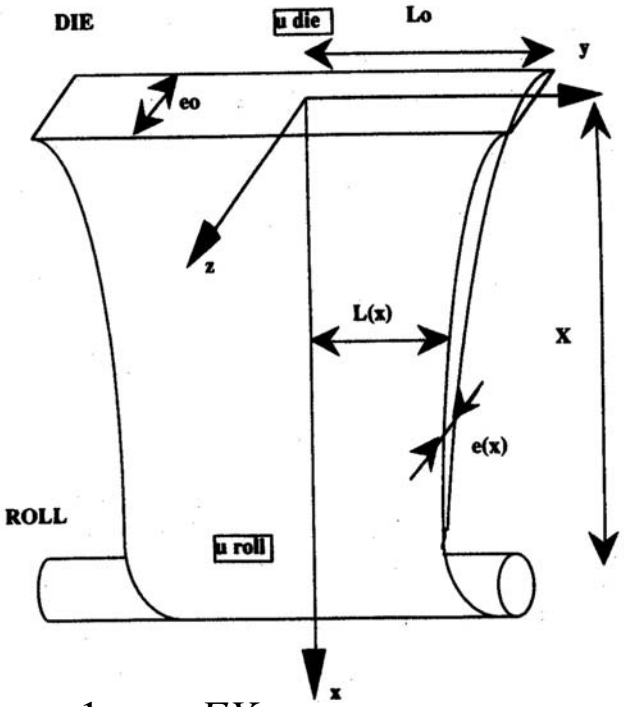
uations:

$$\begin{cases} \boldsymbol{\sigma} = \boldsymbol{\sigma}' - p\mathbf{I} \\ H(\boldsymbol{\sigma}')\boldsymbol{\sigma}' + \lambda \frac{\delta \boldsymbol{\sigma}'}{\delta t} = 2\eta\dot{\varepsilon} \qquad H(\boldsymbol{\sigma}) = \exp\left[\frac{\varepsilon\lambda}{\eta} tr(\boldsymbol{\sigma})\right].\mathbf{I} \\ \frac{\delta \boldsymbol{\sigma}'}{\delta t} = \frac{\partial \boldsymbol{\sigma}}{\partial t} + (\mathbf{u}.\nabla).\boldsymbol{\sigma}' - \nabla.\mathbf{u}.\boldsymbol{\sigma}' - \boldsymbol{\sigma}'^t \nabla.\mathbf{u} \end{cases}$$

itions: $$\boldsymbol{\sigma}.\mathbf{n} = 0 \text{ , } \mathbf{U}.\mathbf{n} = 0$$

a free surface)

numbers: $$Dr = \frac{u_{roll}}{u_0} \text{ , } A = \frac{X}{L_0} \text{ , } De = \frac{\lambda u_0}{X} \text{ , } \frac{1}{E} = \frac{FX}{\eta e_0 L_0 u_0}$$



gy, Y.Demay, J.F. Agassant, Pol. Eng. Sci., 1996, vol.36, No.21

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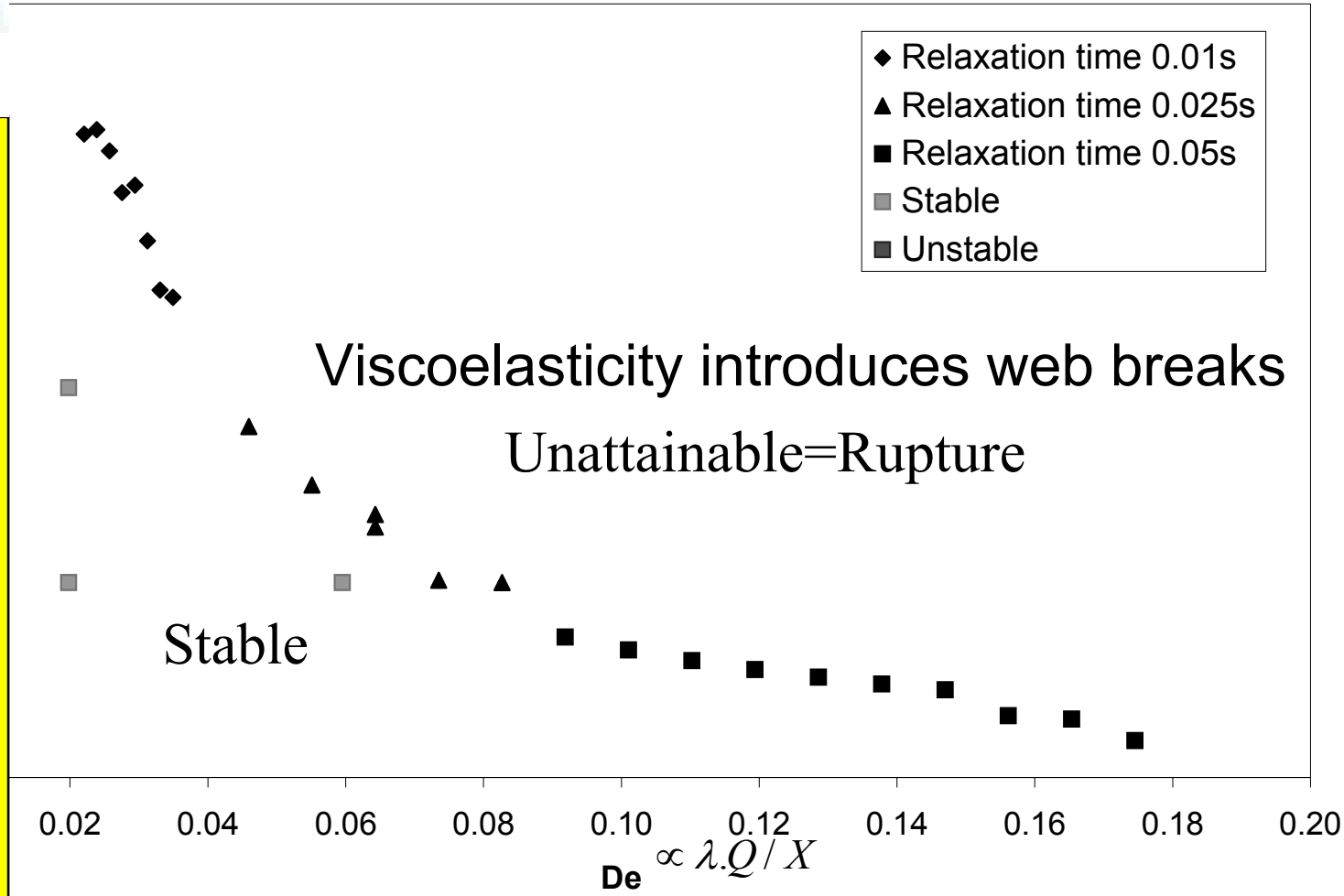
Cast Film Stability Map



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