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Chaired by Dr. Alessandro Lavacchi, Prof. Dr. Andriy Voronov

An economical and environmental alternative to traditional can manufacturing using a new pre-laminated steel

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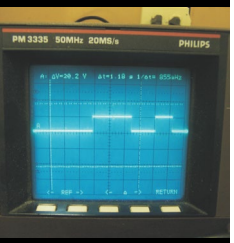
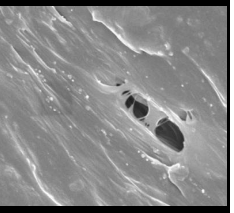
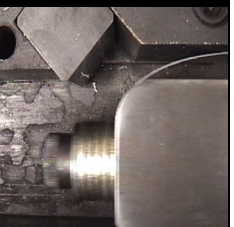
AUT UNIVERSITY

UNC CHARLOTTE



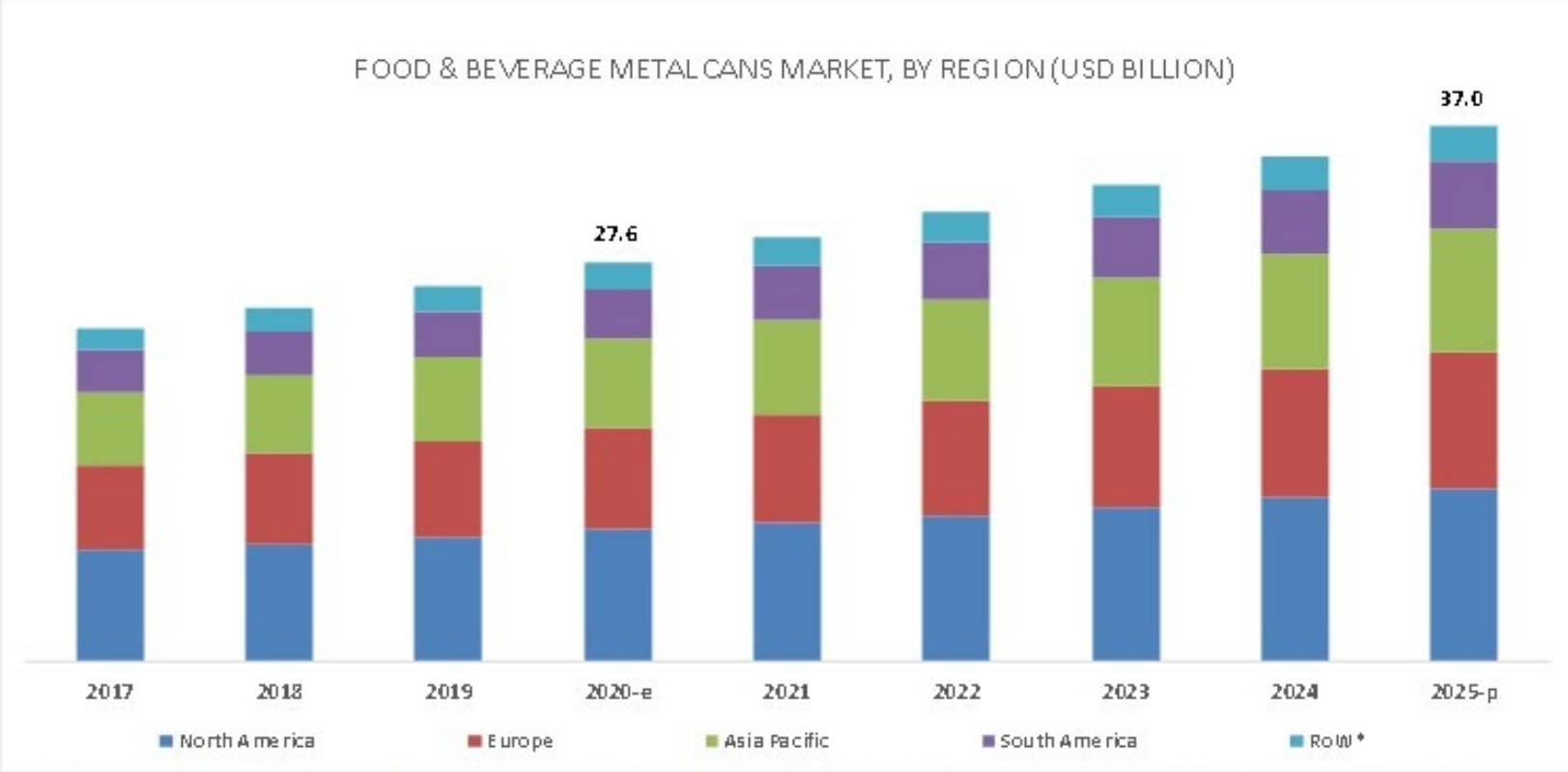



Outline

- Introduction
- Theoretical modelization
- Experimental
- Results
- Conclusions

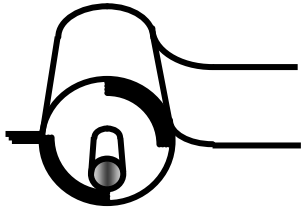
Introduction

Context

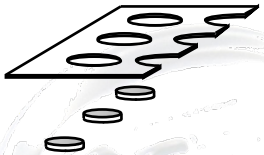


Source: MarketsandMarkets.com

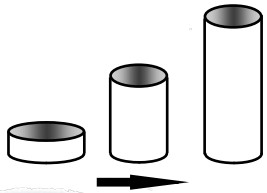
Steps in can manufacturing



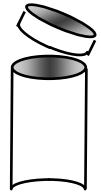
Metal coil



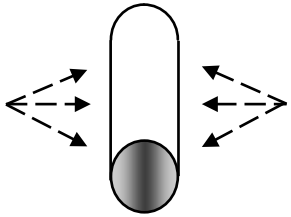
Sheet metal is lubricated and small discs are cutted



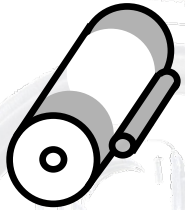
Drawing, Redrawing, Ironing



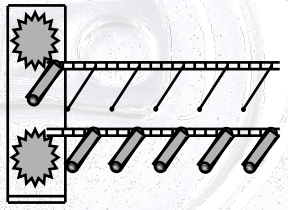
Doming
Cutting



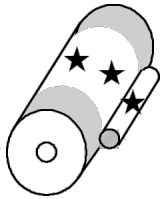
Wash and dry
Lubricant removal



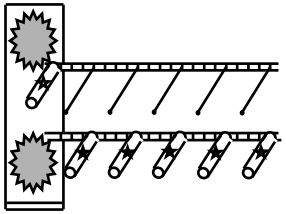
External coating
Base for ink



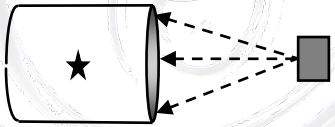
Coating drying on a furnace



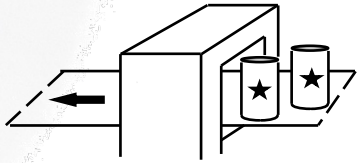
External decoration



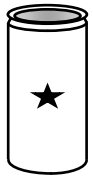
Decoration drying



Sprayed internal coating



Internal coating drying



Necking

Alternative of a precoated sheet

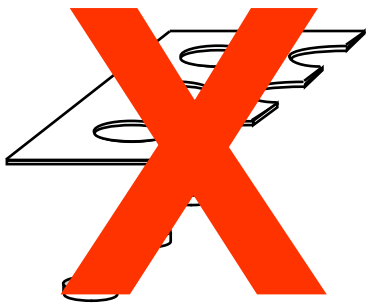
Advantages:

- Reduction of manufacturing steps.
- Reduction of time in the manufacturing cycle.
- Reduction of costs.

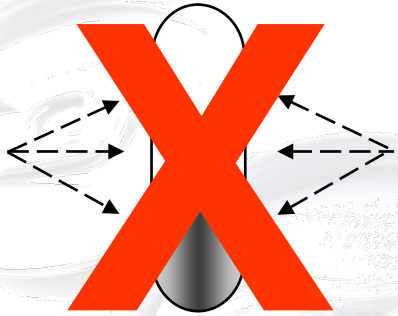
Disadvantages:

- More expensive material.
- Possible damage to polymer layers.

Reduction of steps in can manufacturing

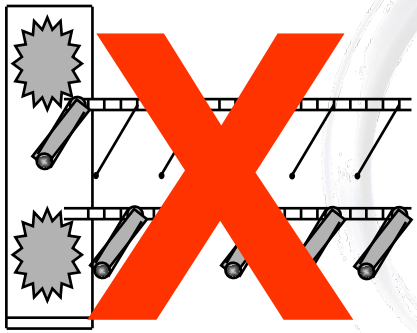


Lubrication



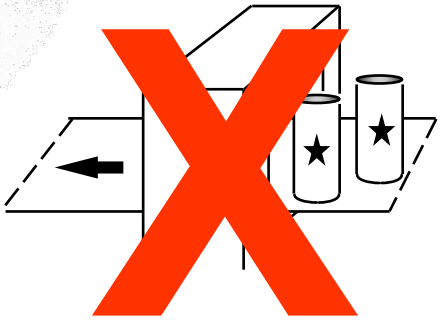
Washing and drying

External coating



Coating drying

Internal coating



Coating drying

Objective of this research

- Study the processability in the use of a steel sheet coated with two polymer layers.
- Carry out a theoretical model of the optimum process conditions.
- Validate this model with experiments on an ironing simulator.

- If viability is demonstrated, it would be possible:

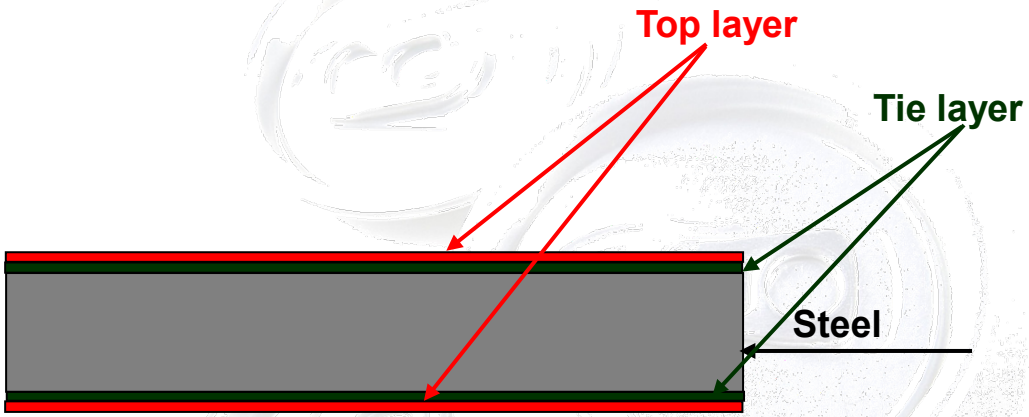
-manufacture metal containers without VOCs emissions ⇒ environmental improvement.

-get a greater internal insulation between beverage and metal.

-improve the mechanical properties of can.

Material characteristics

- **Material provided by ArcelorMittal.**

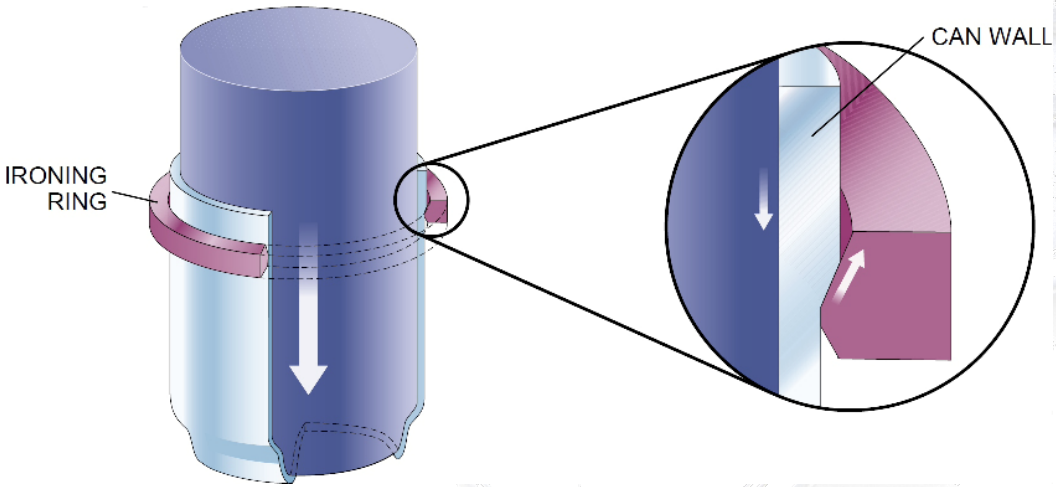


Tie layer: Characteristics of maximum adhesion to metal.

Top layer: Characteristics of high strength and good mechanical properties. Good properties for friction.

Ironing

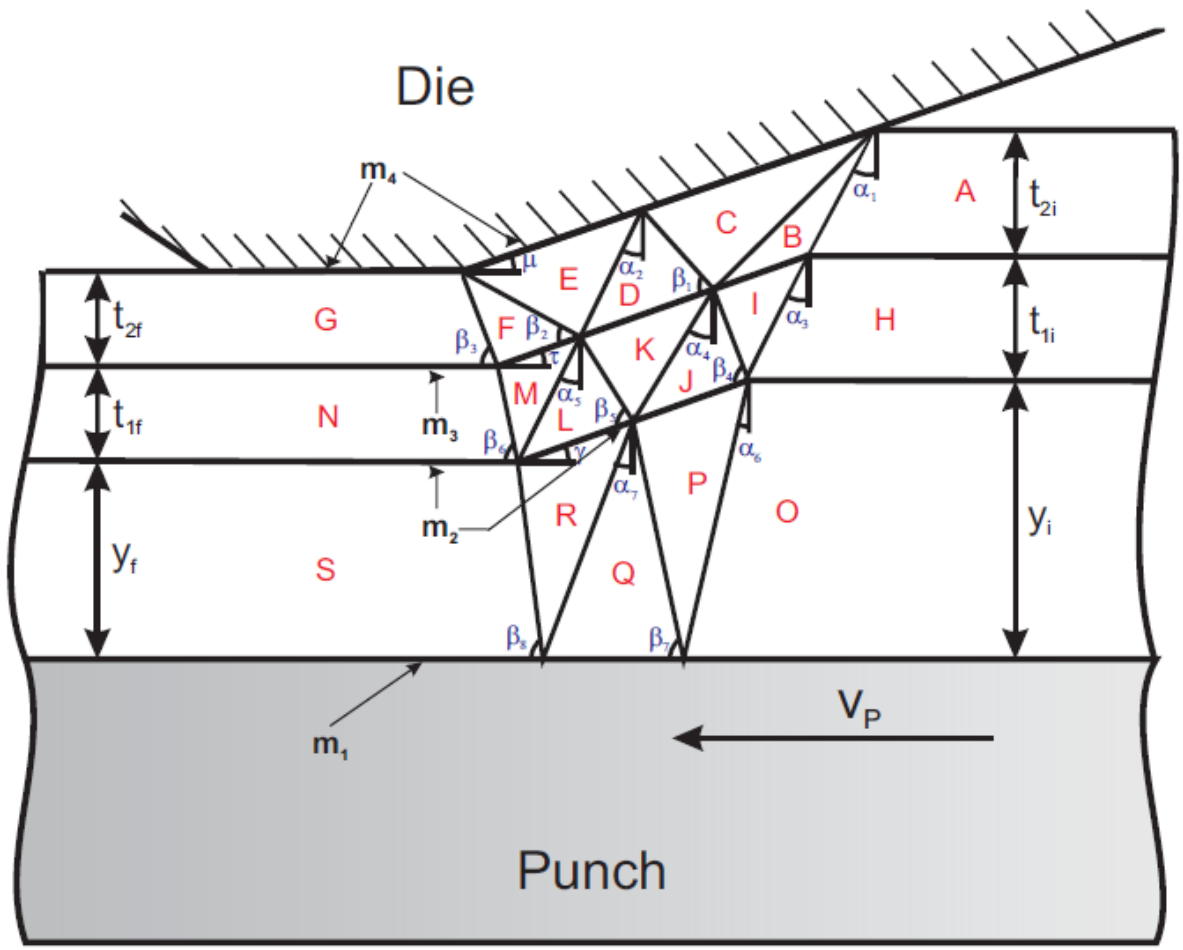
- It's the most crucial step in a polymer-coated can manufacturing.



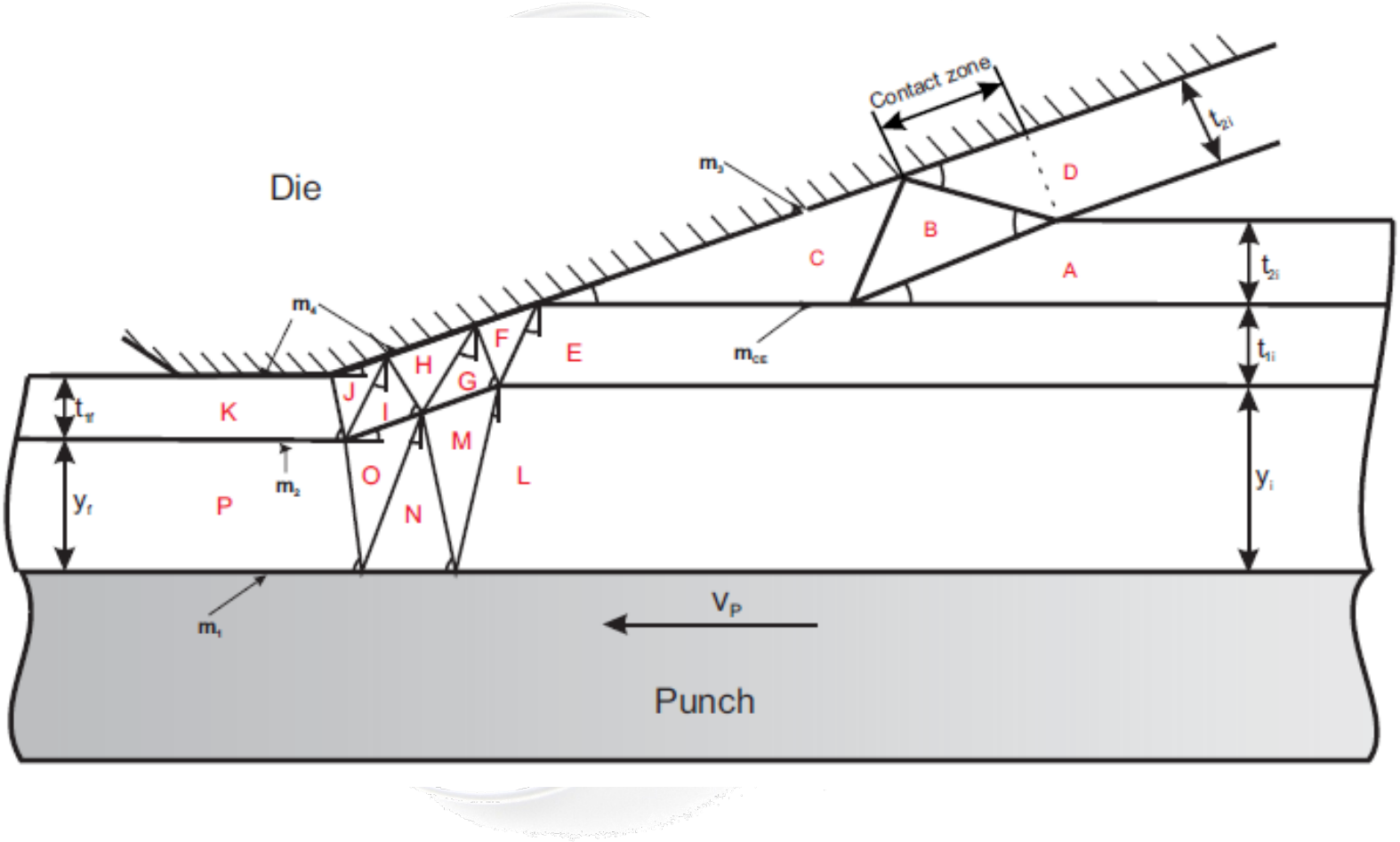
- Variables:
  - Material
  - Temperature
  - Die angle
  - Reduction in thickness
  - Punch velocity

Theoretical Model

Upper bound: Successful ironing

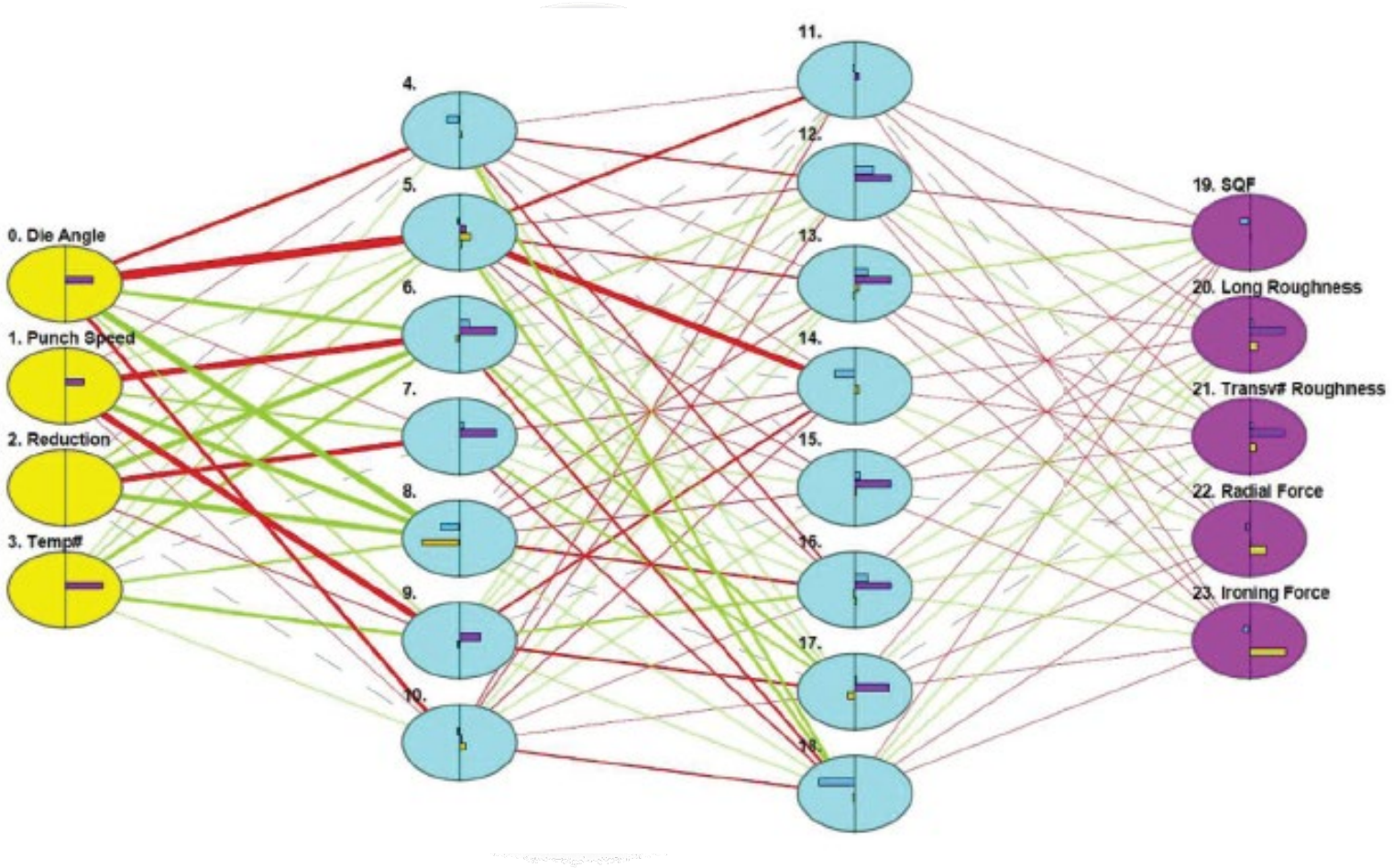


Upper bound: Shaving

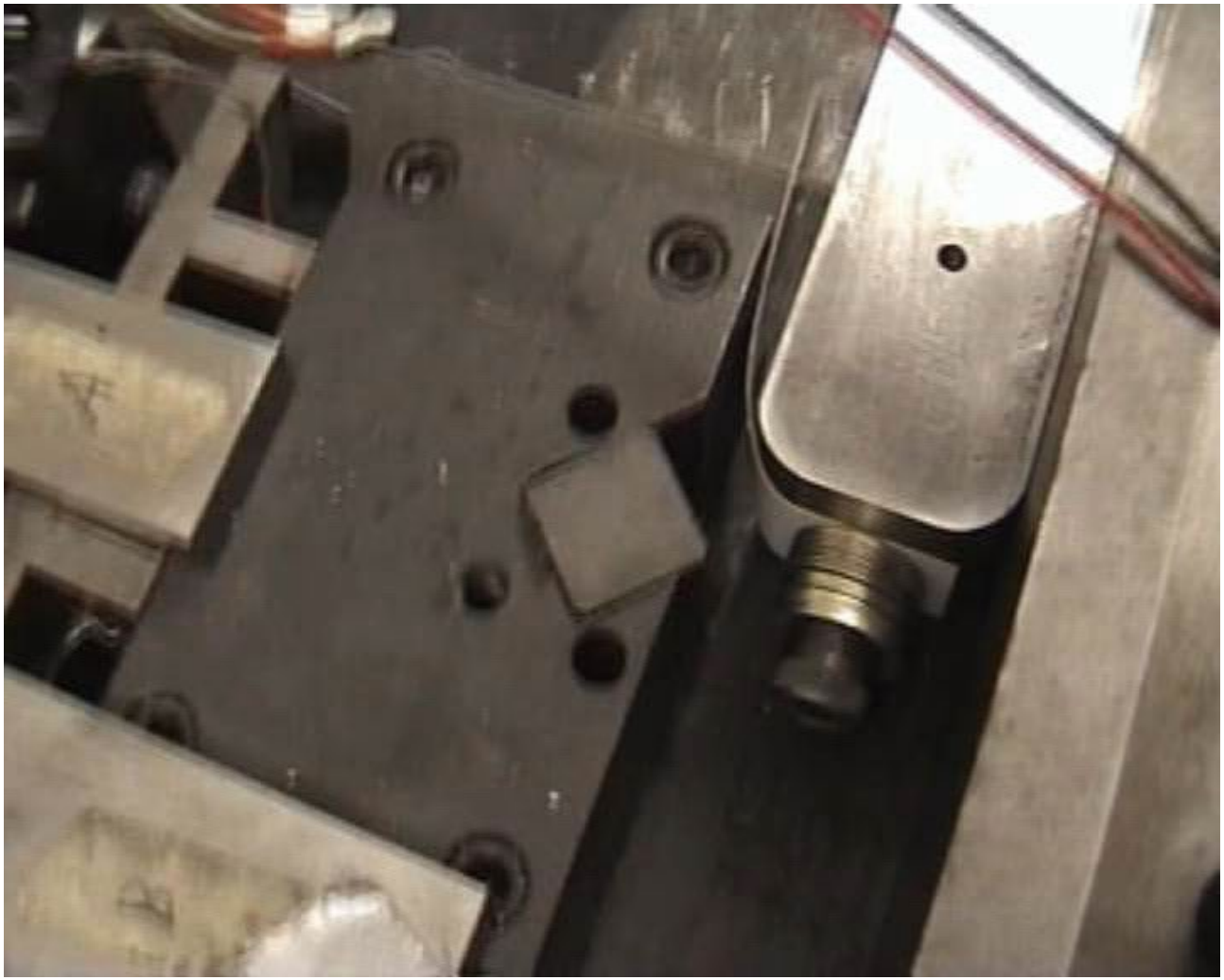


Theoretical Model

Artificial Neural Network of Ironing



Ironing Simulator

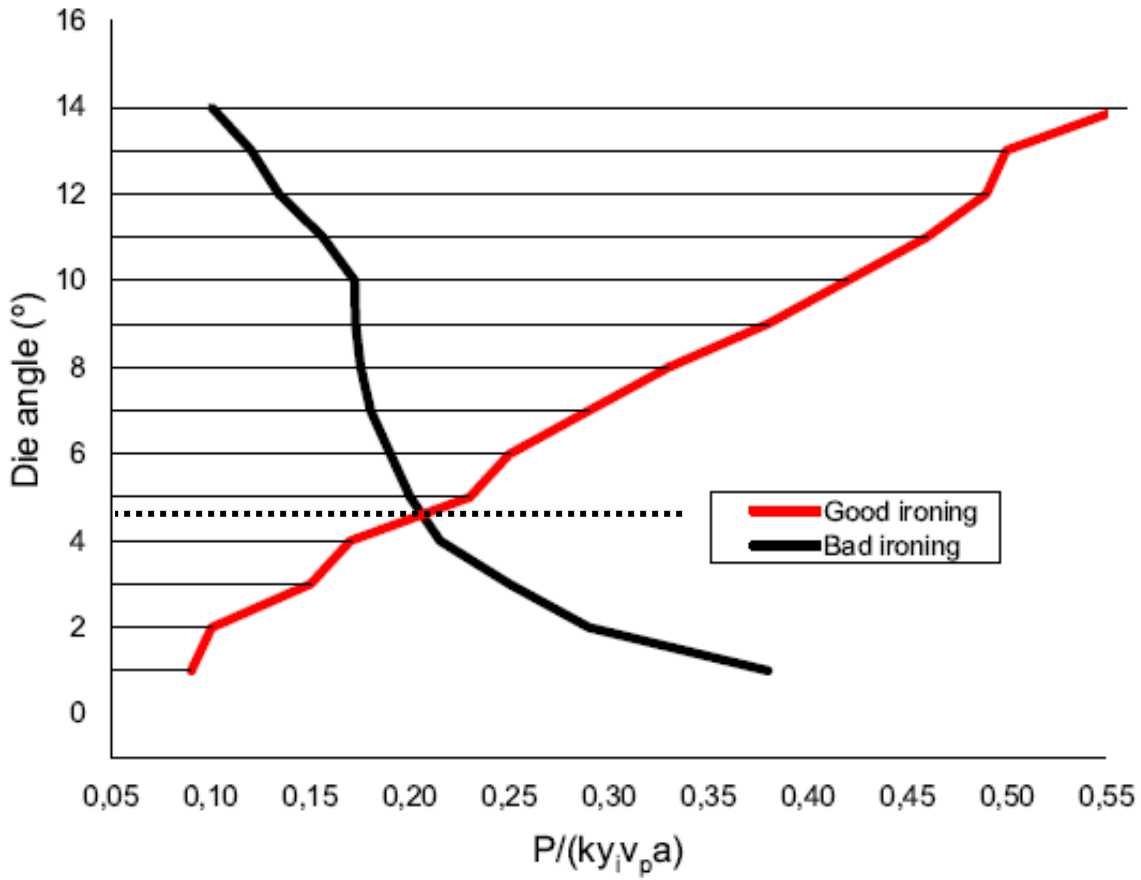


Design of experiments

Process variables		Levels				
Die angle	º	2	4	6	8	10
Punch velocity	m/s	0,5	0,75	1		
Reduction	%	5	10	15	20	
Die temperature	ºC	25	100			

- D-optimal design
- Design Expert™

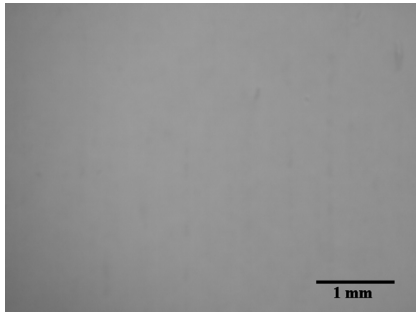
Theoretical results



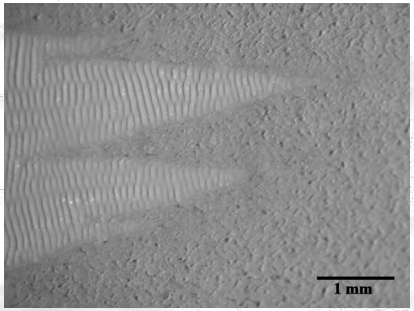
$\Phi \approx 4.8^{o}$

Surface Quality Factor (SQF)

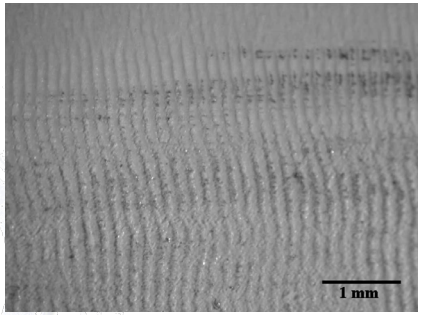
- It's a qualitative factor.
- Surfaces are compared to the following ones:



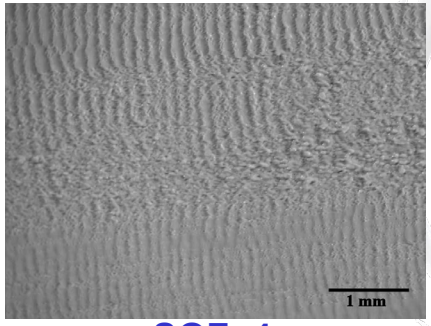
NO IRONING



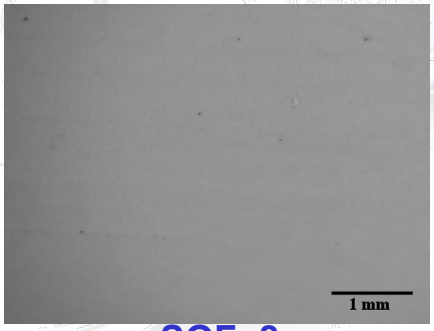
SQF=0



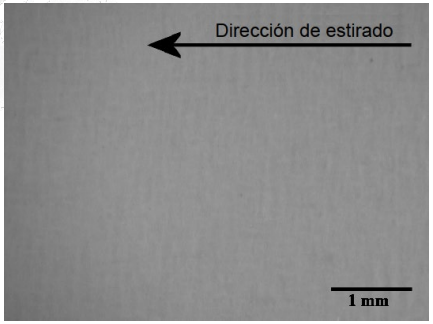
SQF=2



SQF=4

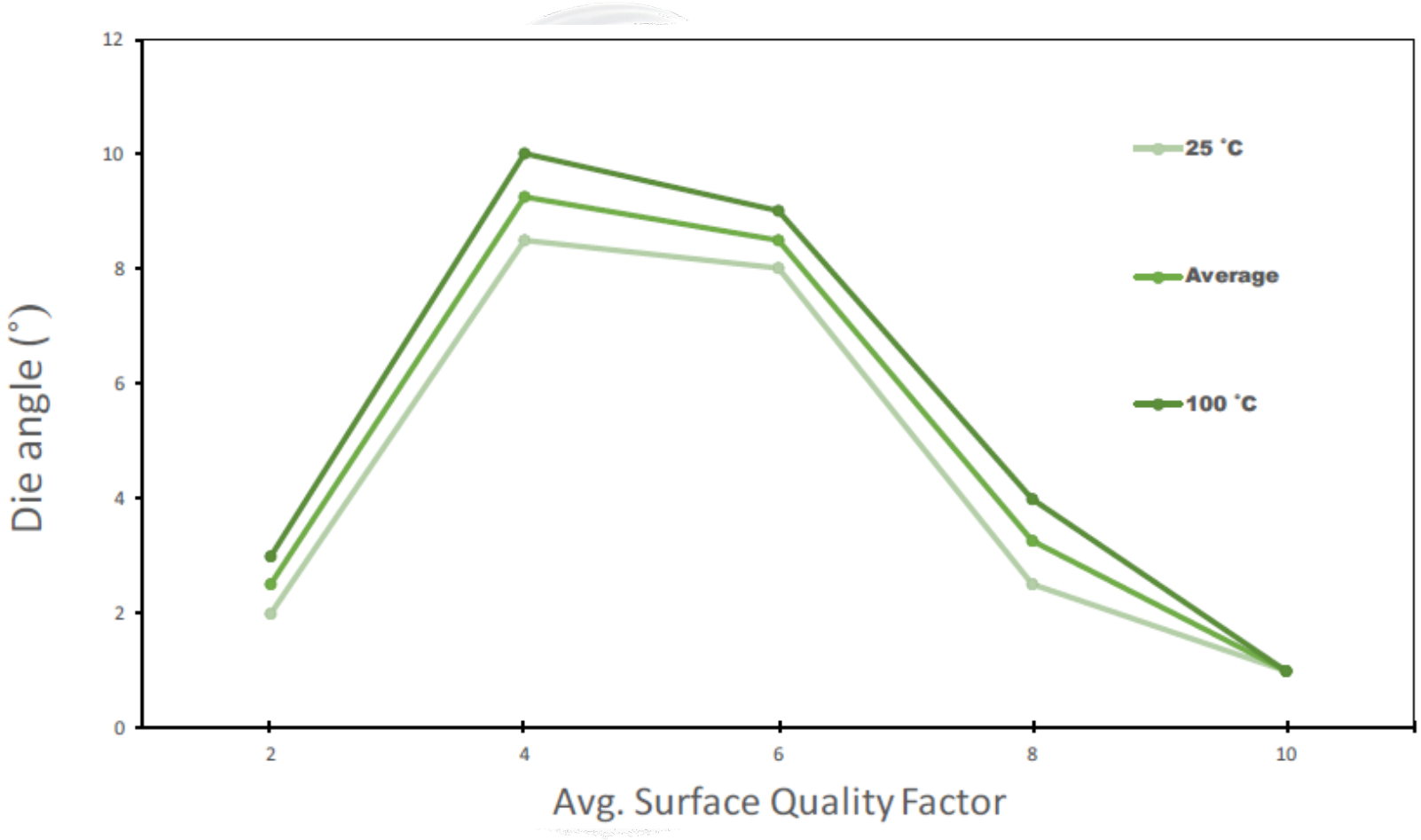


SQF=8

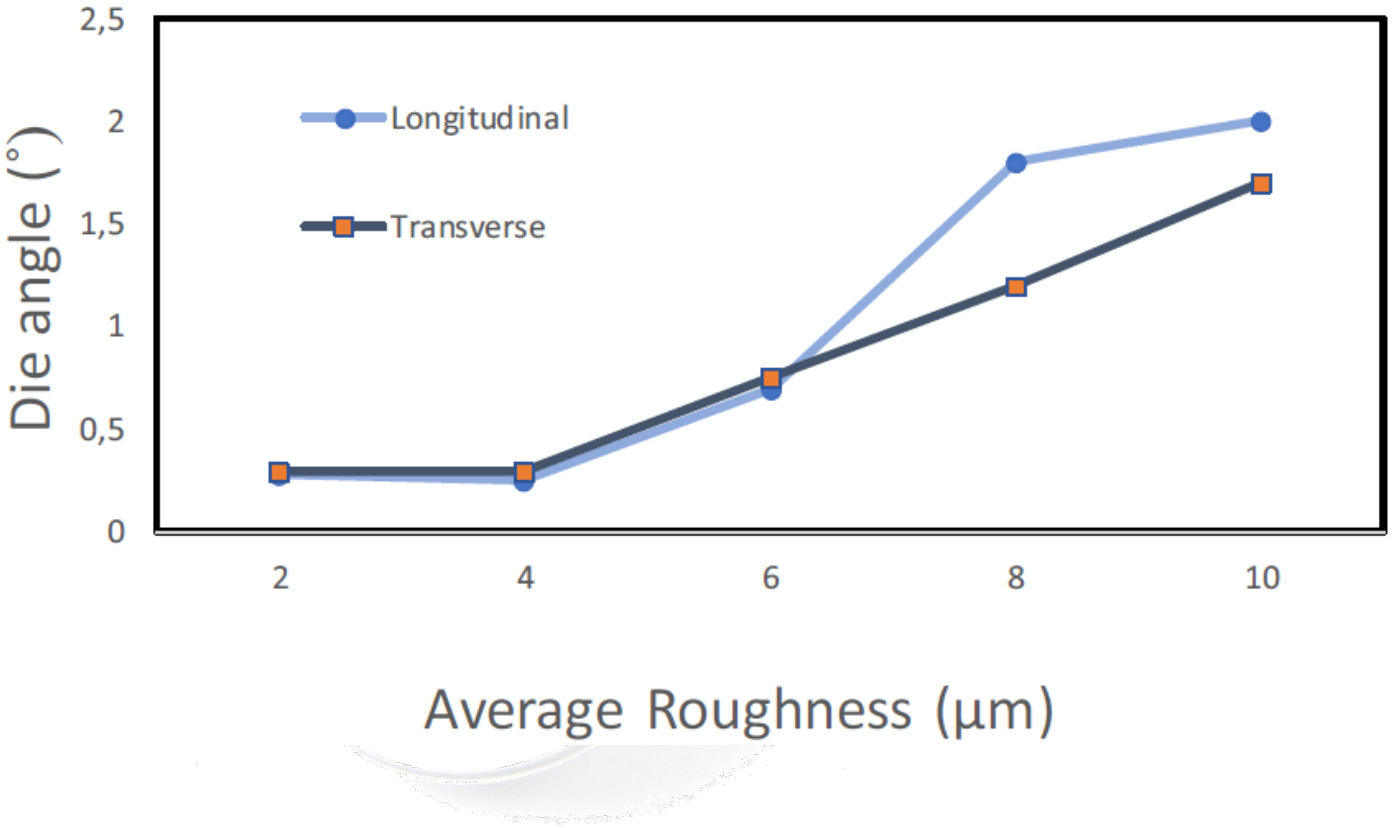


SQF=10

Surface Quality Factor (SQF)



Roughness


2,5
2
1,5
1
0,5
0
Die angle (°)
Longitudinal
Transverse
2
4
6
8
10
Average Roughness (µm)

Conclusions

- Die angle is the most important variable. Good ironings have been achieved with angles of 6º or lower.
- Punch speed and temperature have less significancy over the ironing quality.
- Experimental results are very close to those obtained with the theoretical upper bound models.
- The new 2 layer-polymer coated material survived to the most critical step in can manufaturing (ironing), under certain conditions.
- Several steps in traditional can manufacturing can be eliminated: reduces cost and benefits environment.

Thank you for your attention

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