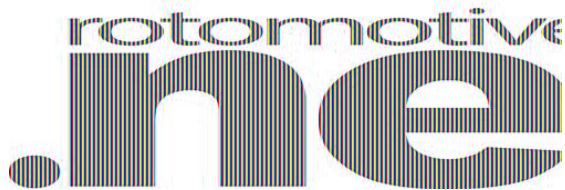


# *WHY*

*is it so difficult to control your*

# COOLING?

*Association of Rotational Molders  
Belfast Meeting, 2026*

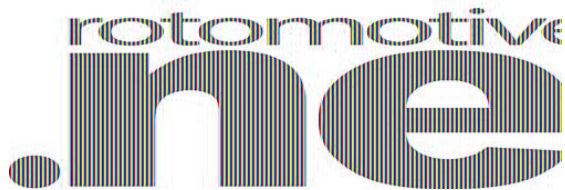


# ***WHY***

*is it so difficult to control your*

# ***SHRINKAGE?***

***Association of Rotational Molders  
Belfast Meeting, 2026***



# OVERVIEW

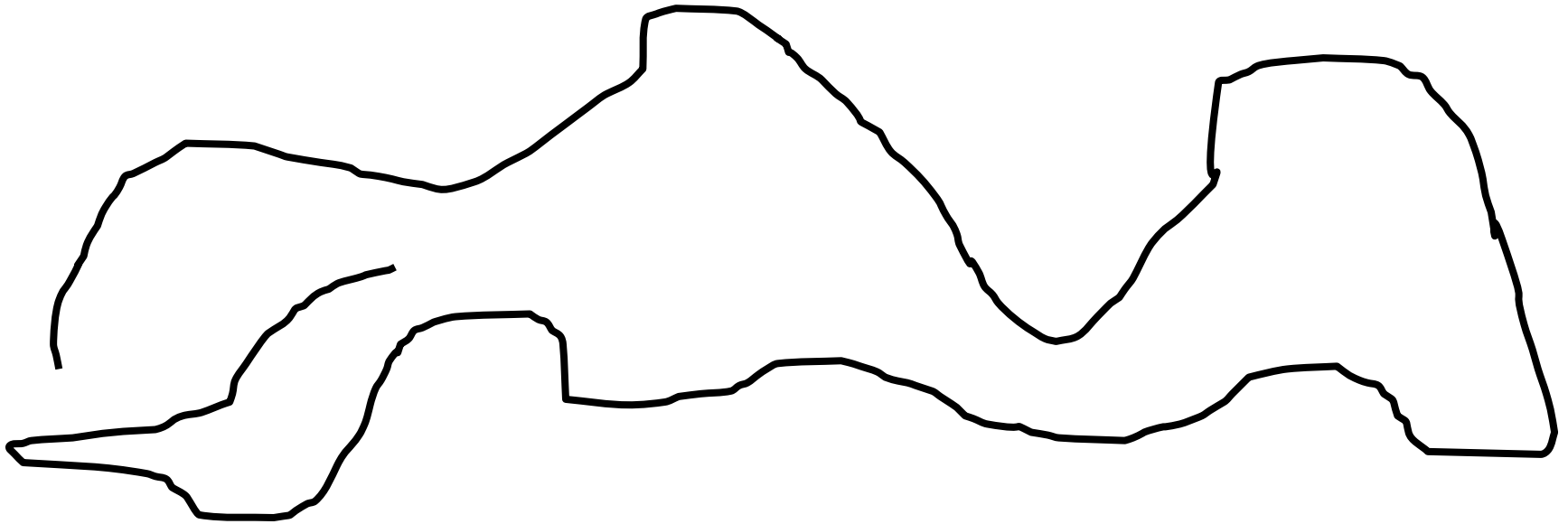
## Polyethylene crystallinity



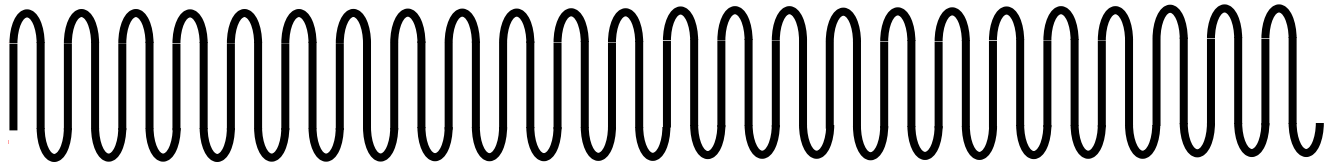
- *Rate of cooling effect*
- *Wall thickness effect*
- *Mold side / air side effect*
- *Release point effect*

***polyethylene crystallinity***

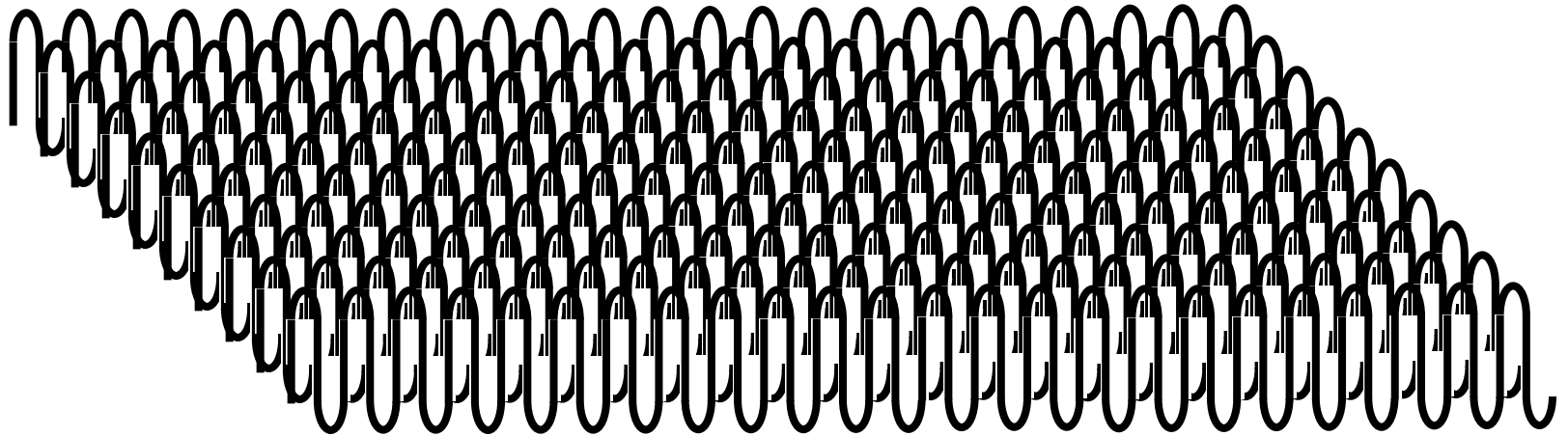
# PE CHAIN FOLDING



80 – 160 C atoms

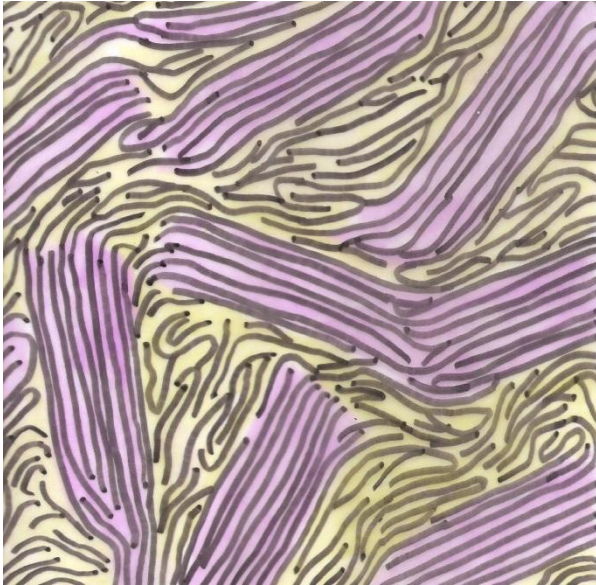


# CHAIN FOLDING MODELS



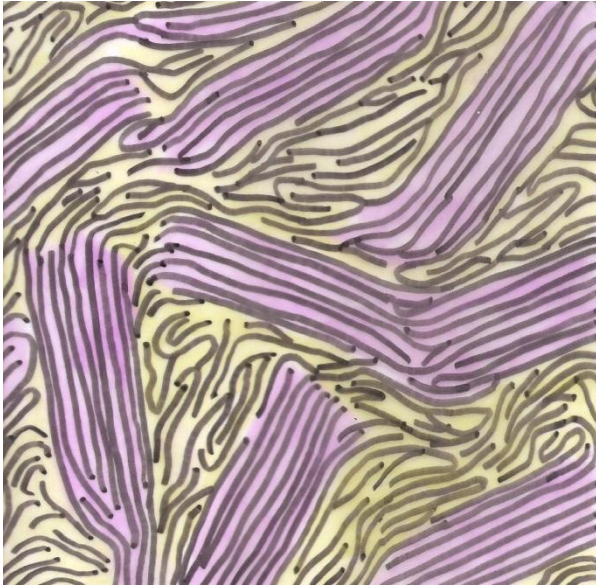
folded chains form *lamellar crystals*

# STRUCTURE OF SOLID PE



- Not all chains fold
- PE is a ***semi-crystalline*** material
- Amorphous & crystalline regions co-exist
- Amorphous: ***toughness***
- Crystalline: ***stiffness***
- ***Roto grade PE***: 50:50 (“50% crystalline”)

# SHRINKAGE OF PE DURING ROTOMOLDING

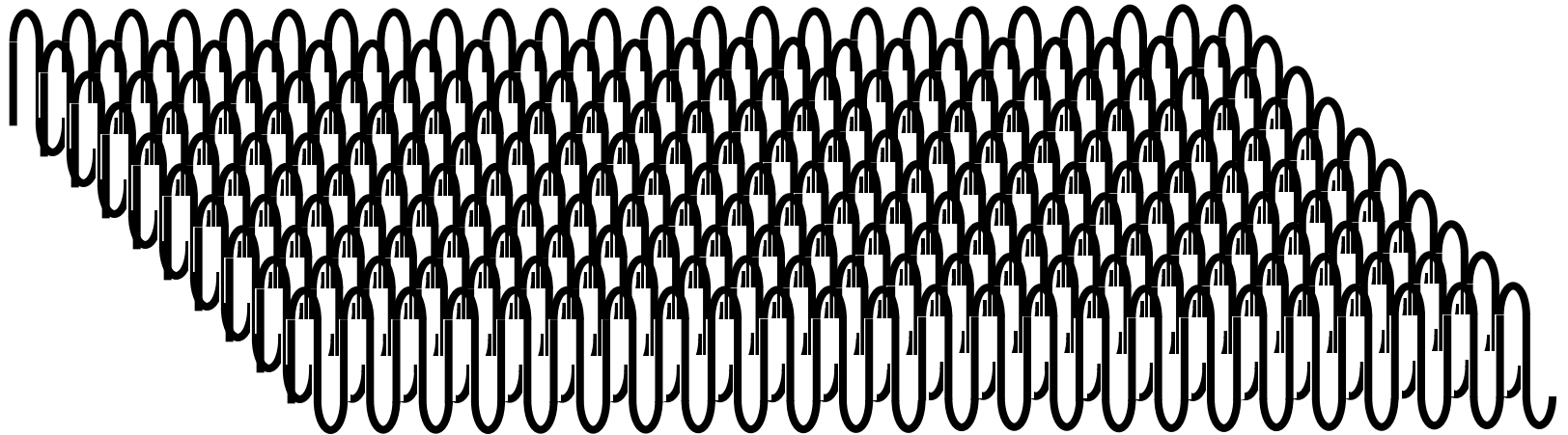


- Amorphous regions have density approx.  $0.850 \text{ g/cm}^3$
- Crystalline regions have density approx.  $1.003 \text{ g/cm}^3$
- In melt state, only amorphous regions exist
- In solid state, both amorphous & crystalline regions exist

***change melt → solid  
results in VOLUME reduction***

***rate of cooling effect***

# CHAIN FOLDING MODELS



**lamellar thickness depends on *cooling rate***

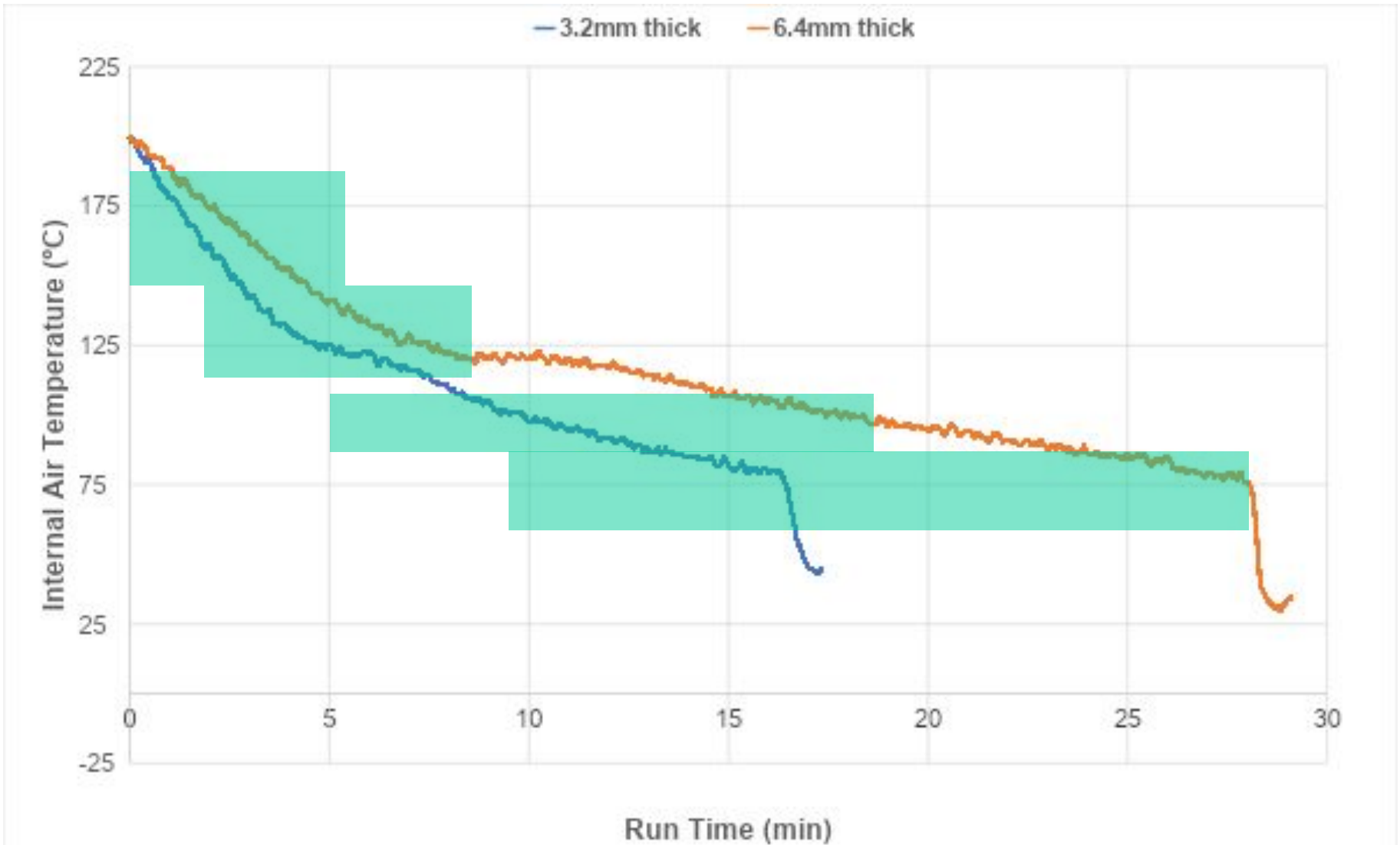
## Density Development vs. Cooling Rate



<b>FAST Cooling</b>	Relatively LOW Crystallinity Relatively LOW Density LESS Shrinkage - !!!
<b>SLOW Cooling</b>	Relatively HIGH Crystallinity Relatively HIGH Density MORE Shrinkage - !!!
<b>VARIATIONS in Cooling</b>	VARIABLE Effects Variations BETWEEN Mouldings Variations WITHIN the SAME Moulding

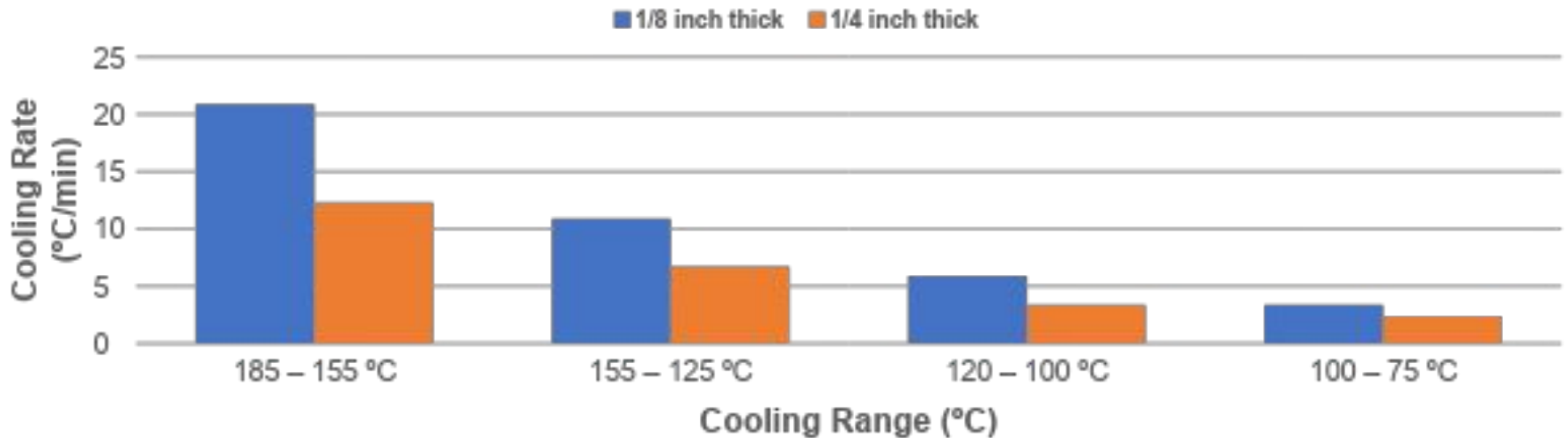
***wall thickness effect***

# PART THICKNESS & COOLING

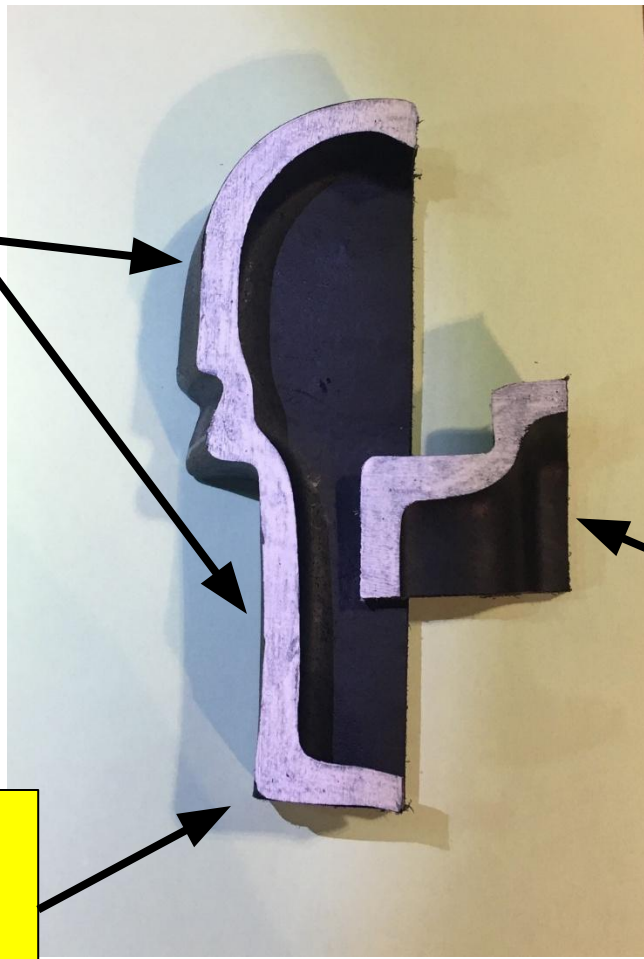


# PART THICKNESS & COOLING

Thickness (inch)	185 – 155 °C 365 – 311 °F		155 – 125 °C 311 – 257 °F		120 – 100 °C 248 – 212 °F		100 – 75 °C 212 – 167 °F	
	(°C/min)	(°F/min)	(°C/min)	(°F/min)	(°C/min)	(°F/min)	(°C/min)	(°F/min)
1/8	20.9	37.6	10.9	19.6	5.9	10.6	3.4	6.1
1/4	12.3	22.1	6.7	12.1	3.4	6.1	2.4	4.3
Ratio 1/8:1/4	1.7		1.6		1.7		1.4	



# VARIATION: 1/2 INCH THICK PART



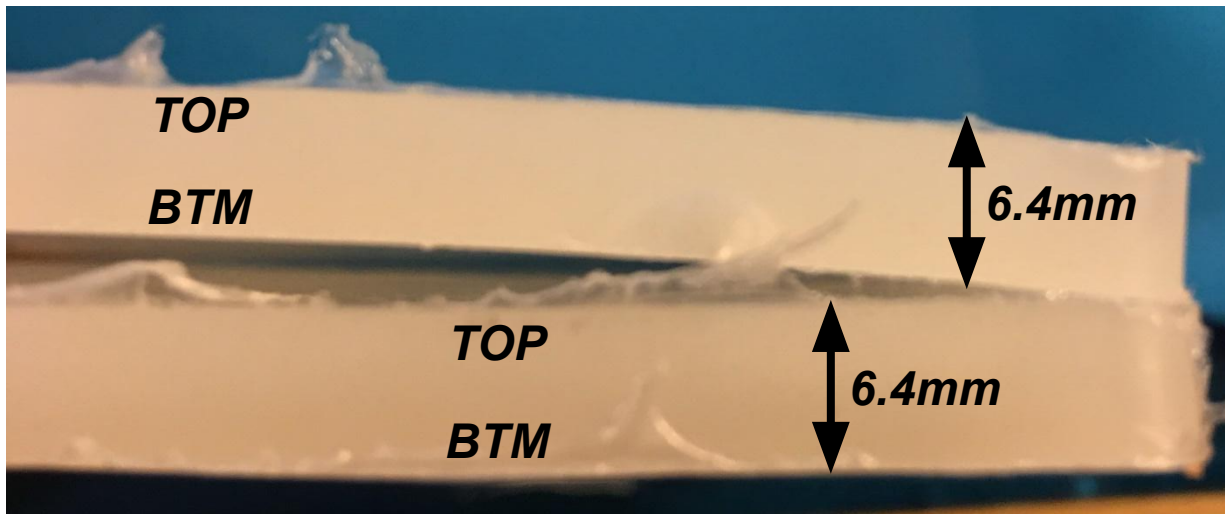
**MAIN WALL  
VARIATION**  
wall thickness  $\pm 20\%$

**INTERNAL  
CORNERS**  
wall thickness  $-50\%$

**EXTERNAL  
CORNERS**  
wall thickness  $+100\%$

***mold side / air side effect***

# “MOLD SIDE / AIR SIDE” EFFECT



TOP	12.4°C/min (22.3°F/min)
BTM	3.1°C/min (5.6°F/min)
TOP	20.2°C/min (36.4°F/min)
BTM	18.7°C/min (33.7°F/min)

FAST cooling  
mold side  
SLOW cooling  
air side



LOWER crystallinity  
mold side  
HIGHER crystallinity  
air side

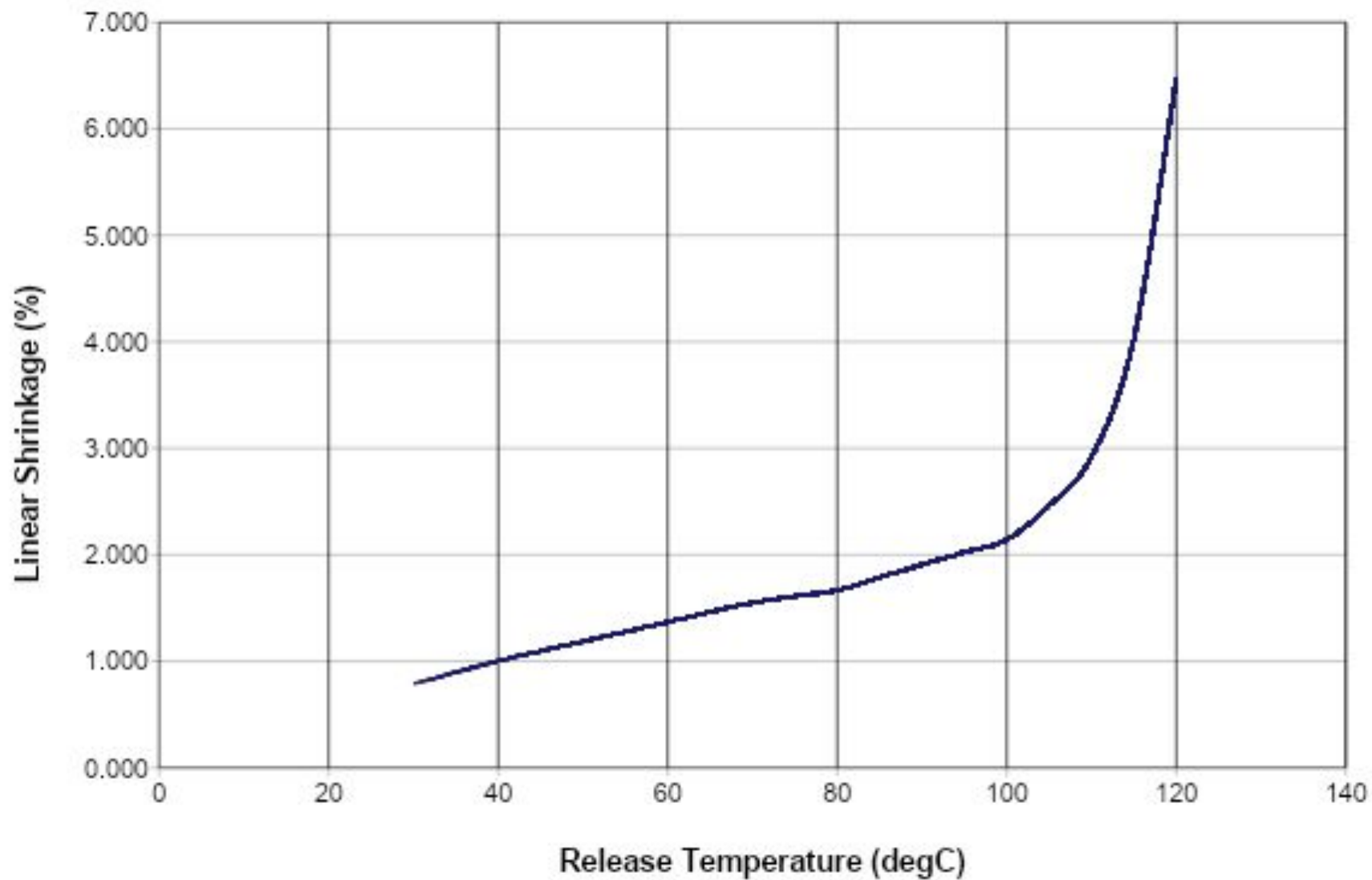


Mold side is LONG  
Air side is SHORT  
Creates **WARPAGE**

## **RELEASE POINT**

*the temperature at which the polymer wall separates from the inside surface of the mold*

***release point effect***



# CHANGING POINT OF RELEASE

Release Temperature (°C)	Release Temperature (°F)	Linear Shrinkage (%)
120	248	6.5
115	239	4.0
110	230	2.9
105	221	2.5
100	212	2.1
95	203	2.0
90	194	1.9
85	185	1.8

- Change in ambient air temperature
- Application of water spray
- MRA choice & condition
- Mold texture
- Material density

# CONCLUSIONS

## *Polyethylene crystallinity*

- *Rate of cooling effect*
- *Wall thickness effect*
- *Mold side / air side effect*
- *Release point effect*

Why control your cooling?

In order to control shrinkage... and warpage

You can't control everything...

Knowledge is power!



**& HOW**

*can you control your*

***SHRINKAGE?***

# Variables that control shrinkage:

## Heating Cycle

Rotation Ratio  
Optimisation

Homogenous  
Oven Heating

Powder Pool  
Passes



Consistent  
Crystallinity

Density of  
Grade

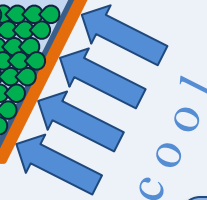
Consistent  
Thermal  
Shrinkage

## Material

Uniform Tool  
Thickness

No Ribs /  
Sharp Corners

Uniform Tool  
Thermals



Even Wall  
Thicknesses

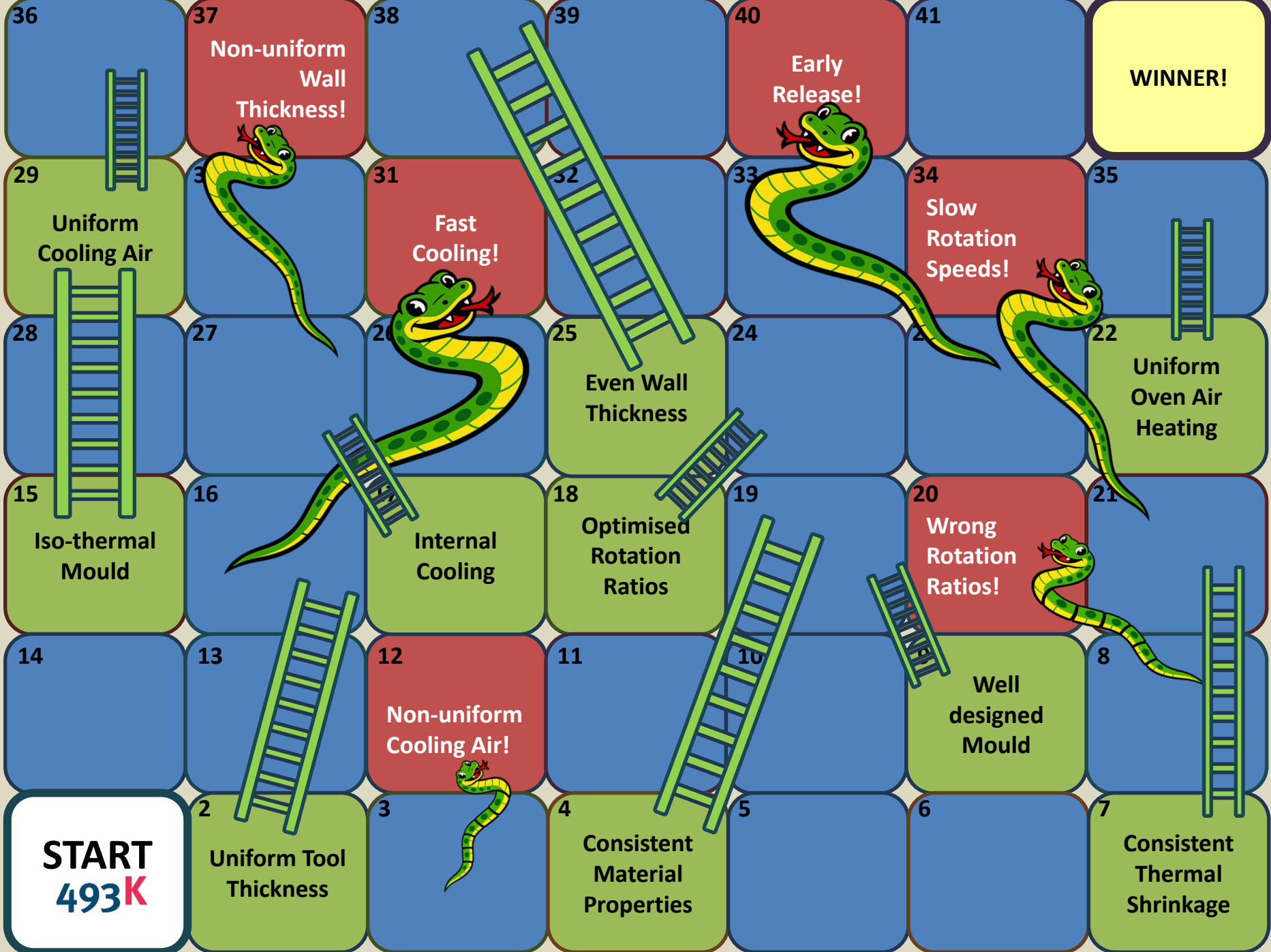
Uniform  
Cooling Air

Late Release

Internal  
Cooling

## Mould

## Cooling Cycle



36

37  
Non-uniform  
Wall  
Thickness!

38

39

40  
Early  
Release!

41

WINNER!

29  
Uniform  
Cooling Air

30

31  
Fast  
Cooling!

32

33

34  
Slow  
Rotation  
Speeds!

35

28

27

26

25  
Even Wall  
Thickness

24

23

22  
Uniform  
Oven Air  
Heating

15  
Iso-thermal  
Mould

16

17  
Internal  
Cooling

18  
Optimised  
Rotation  
Ratios

19

20  
Wrong  
Rotation  
Ratios!

21

14

13

12  
Non-uniform  
Cooling Air!

11

10

9  
Well  
designed  
Mould

8

START  
493K

2  
Uniform Tool  
Thickness

3

4  
Consistent  
Material  
Properties

5

6

7  
Consistent  
Thermal  
Shrinkage

# Variables that control the local wall thickness:

## ① local mould temperature & ② powder pool residence time

*TIP: Heat the empty mould in the oven for 2mins. Remove it and view with an infra-red camera where the natural hot spots are.*

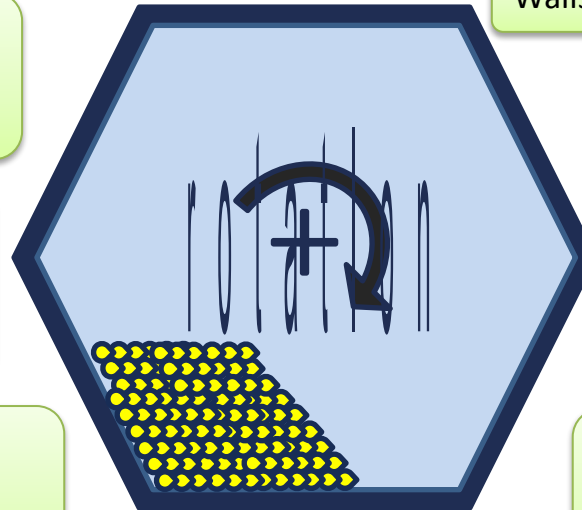
NB: Parts will be thinner in those areas that pass through the powder pool less often.

NB: Powder lays down on the mould somewhere between 85C and 130C IAT. This is when the rotation speed & ratio counts!

Parts will be thinner in places where geometry inhibits powder flow (dry under the waterfall).

*TIP: Process a 2mm part in the mould & easily spot the holes or thin sections.*

h e a t  
↓ ↓ ↓ ↓



↑ ↑ ↑ ↑  
h e a t

More even oven temperatures reduce the likelihood of uneven wall thicknesses.

Walls are thicker at the hottest parts of the mould.

Stalling rotation can cause areas of variable temperature – useful to heat up cold sections!

*TIP: Increase rotation speeds to increase the number of powder pool passes on each section of the mould.*

NB: Part walls will be thinner at colder parts of the mould (e.g. shielded areas, deep ribs, flanges)

Correctly adjusted rotation ratios provide the biggest improvement to wall thickness uniformity.

Uneven wall thicknesses will account for more uneven shrinkage (AKA warping)

- Temperature independent
- Bubbles are no problem!
- No gel!
- ex-ultra-sonic users...

	Non Destructive	Electronic Reading	Material Density Independent	Measures through Bubbles	Coupling free	Temperature Independent
Ultrasonic	✓	✓	X	X	X (gel)	X
Cut & Calliper	X	X	✓	✓	✓	✓
K-Metron	✓	✓	✓	✓	X (mag)	✓



K-Metron

15.0 Pos

Error

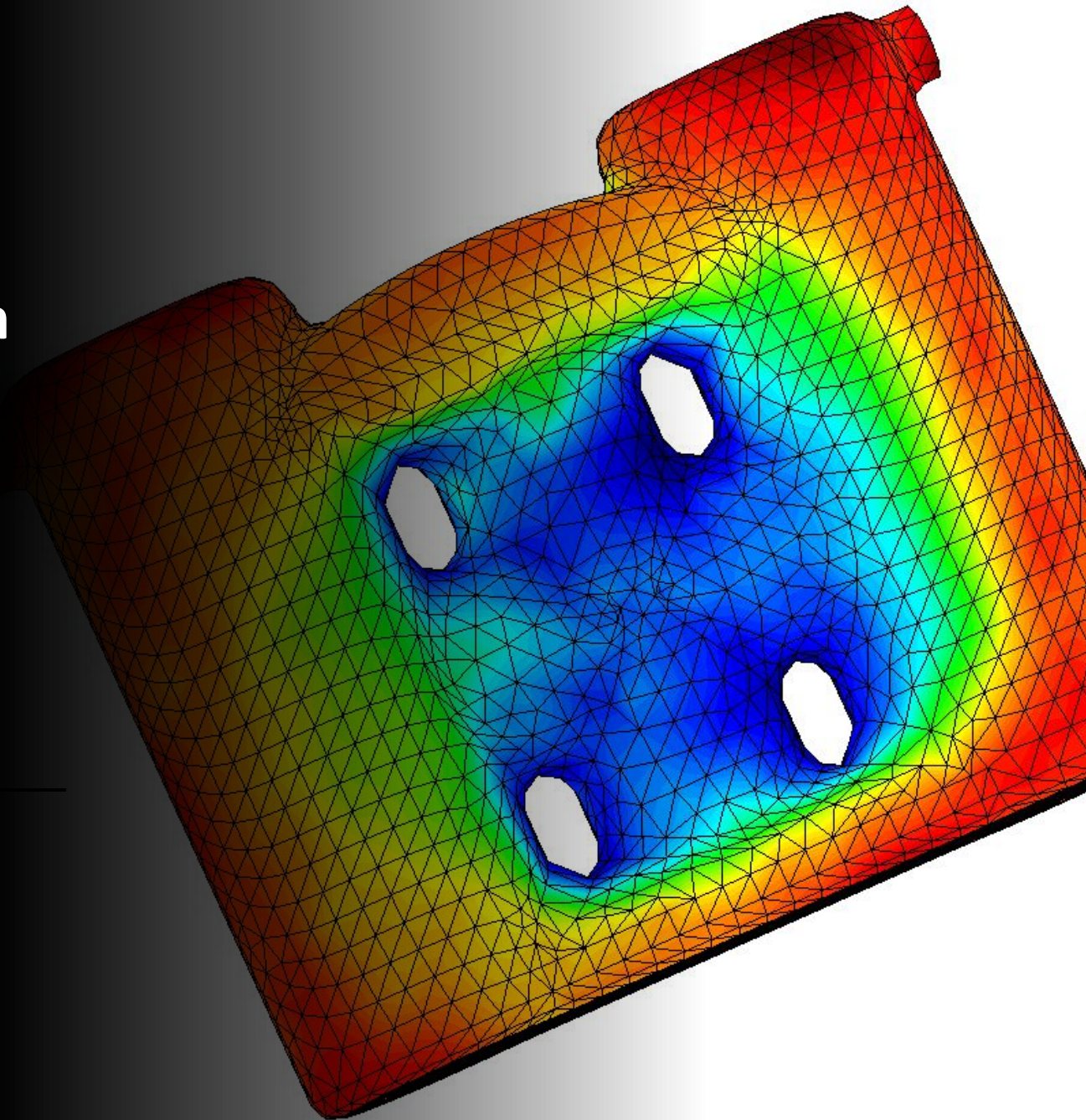
Power

Press Trigger  
to Transm



# Control Wall Thicknesses with Simoulding Simulation

- ① STEP File
- ② Process Parameters



Contour Fill of Thickness [mm].

# Simoulding demonstrates different thicknesses cool differently

