

Low Pressure Reaction Injection Moulding - RIM



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Comparison

Potlife

Tooling

Process

Pros & Cons

Rapid Tool

	Subject Matter	Objective
1	Why RIM?	Understand the purposes of using RIM
2	RIM Materials vs. Objet	Grasping the comparison of both
3	Comparison RIM Materials	Understanding the choice of RIM materials
4	RIM vs. Injection Molding	Comparing materials RIM vs. Injection molding
5	Potlife – Concern	Understanding the issue of Potlife with RIM
6	RIM Mixing Machine	Grasping the purpose of this tool
7	Why Use Tool for RIM	Purpose of RIM tool
8	RIM Tooling - Process	Understand the process using RIM tooling
9	RIM – Pros & Cons	Understanding Advantages/Disadvantages
10	Rapid Tooling & RIM	Grasping how Rapid Tooling and RIM work

Why Rim?

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Simulation of materials of serial production:

- Like rubber polyethylene, polypropylene, ABS, PVC, other

Used in the stage of development and preproduction:

- For automotive industry, for household appliances, for rail vehicles, in aviation, in boat building and for other technical parts

When Objet/PolyJet materials:

- Do not fulfill the mechanical requirements
- The number of prototypes is higher than the printable numbers

Injection Molding vs. Objet Materials - Comparison

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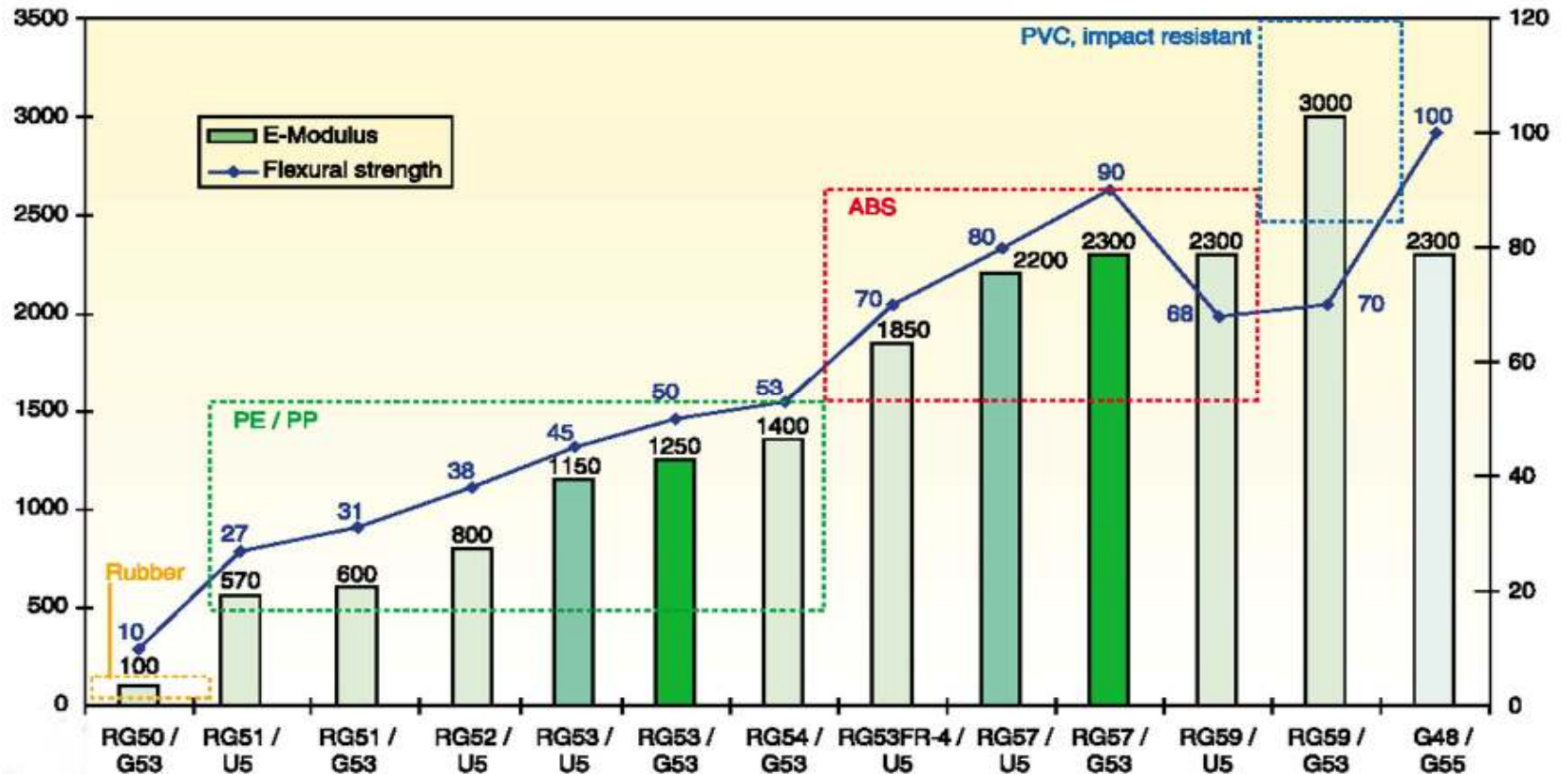
Injection Mould Materials	Density	E-modulus	Flexural Strength	Tensile Strength	Elongation at Break	Impact resis.	HDT
	ISO 1183 g/cm ³	ISO 178 MPa	ISO 178 MPa	ISO 527 MPa	ISO 527 %	ISO 179 kJ/m ²	ISO 75B °C
LDPE	0,92	400	10	10	400	n.t.	40
HDPE	0,95	1200	23	30	500	n.t.	60
PP homopolymer	0,9	1400	37	30	150	10	55
kPVC	1,4	2000	-	62	30	5	70
HIPS	1,03	2000	55	30	40	8	78
PA6	1,13	2200	100	80	50	25	80
PC	1,2	2400	85	63	6	64	128
ABS	1,06	2500	75	50	40	22	95
OBJET/POLYJET Materials							
FullCure 720	1,1	2870	75	60	15-25	39	48
VeroWhite	1,1	2495	75	50	15-25	37	58
VeroBlue	1,1	2740	83	55	15-25	42	48
VeroBlack	1,1	2190	79	50	18	35	62

Note: PolyJet materials in ASTM – difficult to compare with ISO

- Above illustrates mechanical properties of materials in Injection Molding (expensive)
- It can be seen that Objet materials can be used for several applications as well
- Two parameters - Elongation at Break & Heat Distortion Temperature – limit usage here

RIM Materials

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- Above are the two component polyurethane resin-based RIM materials
- Left axis shows the E-Modulus and the right axis shows the Flexural strength
- The colored boxes show the equivalent Injection Mould materials

RIM & Injection Molding Materials – Comparison

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Injection molding materials		Density	E-modulus	Flexural strenght	Tensile strenght	Elongation at break	Impact resistance	HDT
RIM materials		ISO 1183	ISO 178	ISO 178	ISO 527	ISO 527	ISO 179	ISO 75B
Resin A	Hardener B	g/cm ³	MPa	MPa	MPa	%	kJ/m ²	°C
RG50	G53	1,1	-	-	5	200	-	-
LDPE		0,92	400	10	10	400	n.t.	40
RG51-HS	G53	1,15	450	20	25	150	75	65
RG51	U5	1,2	570	27	34	70	36	110
RG51	G53	1,2	600	31	34	100	40	62
RG52	G53	1,2	800	38	30	60	42	72
HDPE		0,95	1200	23	30	500	n.t.	60
RG53	U5	1,2	1300	54	38	20	50	120
RG53	G53	1,2	1400	58	38	25	60	110
RG54	U5	1,2	1400	53	44	12	75	115
PP homopolymer		0,9	1400	37	30	150	10	55
RG53-Fibre	U5	1,2	1730	55	35	11	48	63
kPVC		1,4	2000	-	62	30	5	70
HIPS		1,03	2000	55	30	40	8	78
RG53-FR-4	U5	1,27	2200	70	45	5	35	110
RG57	U5	1,2	2200	80	45	13	65	125
PA6		1,13	2200	100	80	50	25	80
RG57	G53	1,2	2300	90	54	9	100	-
RG59	U5	1,8	2300	68	46	-	29	65
PC		1,2	2400	85	63	6	64	128
EP		1,25	2400	-	50	3	4	230
ABS		1,06	2500	75	50	40	22	95
PA66		1,13	2800	120	100	50	12	77
RG59	G53	1,8	3000	70	45	4	30	60
PET		1,3	3100	-	80	4	3	65
PMMA		1,18	3200	-	64	3	2	85
PS		1,04	3500	95	50	3	2	80
UP		1,25	3500	100	50	2	3	80
PP+35%GF		1,15	4000	-	90	3	10	148
PA66+30%GF		1,37	5900	145	135	5	24	215
PC+30%GF		1,43	6700	145	144	4	10	145

See next slide for explanation

RIM & Injection Molding Materials – Comparison

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Rapid Tool

- The content of previous graph is very helpful in PU selection
- The numbers help selecting the right PU based RIM material
- Which will simulate the injection moldable materials
- E.g.:
 - If someone wants to have polyamide (nylon) like RIM material
 - RG57 resin with G53 Hardener can be used
 - Which has roughly the same mechanical parameters as
 - Injection moldable PA6 polyamide

Potlife Issue

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Biresin® Low pressure RIM-systems														
Resin A-polyol	Biresin®	RG50	RG51		RG52	RG53		RG54	RG53 FR-4	RG57		RG59		G48
Hardener B-isocyanate	Biresin®	G53	U5	G53	G53	U5	G53	U5	U5	U5	G53	U5	G53	-
Mixing ratio pbw	Resin Hardener	100 18	100 64	100 70	100 64	100 75	100 80	100 70	100 50	100 80	100 90	100 28	100 30	-
Potlife	[sek]	100	50	50	60	55	55	55	40	40	50	60	60	45-60min
Demoulding time	[min]	15	> 10	> 10	> 10	> 10	> 10	> 10	> 8	> 10	> 10	> 10	> 10	-

- The RIM materials have very good mechanical properties
- Unfortunately when you mix resin and hardener you have a very short “potlife”
- “Potlife” is the timeframe that you have for mixing resin with hardener
- You have to “pour” the mixed resin/hardener into the mould within this time frame
- RIM materials potlife are given in seconds
- RIM Machine allows you to mix the resin/hardener and fill-up the mould

Solution – RIM Mixing Machine

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Rapid Tool

- RIM machine has two separate containers
- One holds the resin the other holds the hardener
- Both containers have an individual pump
- Pumps push the material to the mixing head
- The mixing ration can be adjusted by the pumps volume adjustment
- On the front of the mixing head is a so called „static mixer“
- The static mixer will mix the RIM resin and hardener
- Mixer inserted into the mould → directly injected into mold within seconds
- The UNIDOS100 RIM machine can fill-up 1 liter of mixed material in 60sec
- If you need bigger volume, bigger RIM machines exist



RIM – Tooling Options

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Pros & Cons

Rapid Tool

- Silicon Mould:
 - Indirect Rapid Tooling - Objet print of an accurate master
 - Master model is used for making a silicon mold
- PolyJet/ PolyJet Matrix Mould:
 - Direct Rapid Tooling - Objet print of an accurate mold

Process - Filling Up the Silicon Mold

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Rapid Tool



- Static mixer is inserted into the silicon mould (left side)
- The mixed resin/hardener fills up
- (The other silicon mould has already been filled up - right side)

Process – Making RIM Parts

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Pros & Cons

Rapid Tool



- RIM can also be very fun as can be seen here!
- Note: Wearing rubber gloves is imperative when working with RIM parts

Process – End RIM Products

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Pros & Cons

Rapid Tool



- The above parts were made for Robert Bosch Power Tool
- In Bosch this is the second phase of the development of a new chain-saw
- The RIM parts were used for real testing...
- RIM prototypes actually cut tree trunks as part of testing phase

RIM - Advantages

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Rapid Tool

- Objet/PolyJet models are used in making master models
- For RIM Silicon Mould, Objet models provide highly accurate parts
- Tooling costs is very low
- Making RIM tools is inexpensive
- The mechanical parameters of RIM parts simulate serial production parts

RIM – Limitations

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Rapid Tool

In Silicon Mould for RIM:

- 60-80 parts can be made
- After 60-80 parts, the Silicon Mould is not usable any more

In Rapid Tooling for RIM:

- No limit in quantity, but release agent is necessary for every part

Productivity of RIM is smaller than Injection Mould process

Rapid Tooling for RIM

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- This is the part that will be made by RIM in the workshop in two ways:
 - Silicon moulding
 - Via Rapid Tooling

Part & Tool

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Picture here shows:

- Master mold (Rapid Tooling for RIM)
- Master model for silicon molding for RIM

The Tool

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Comparison

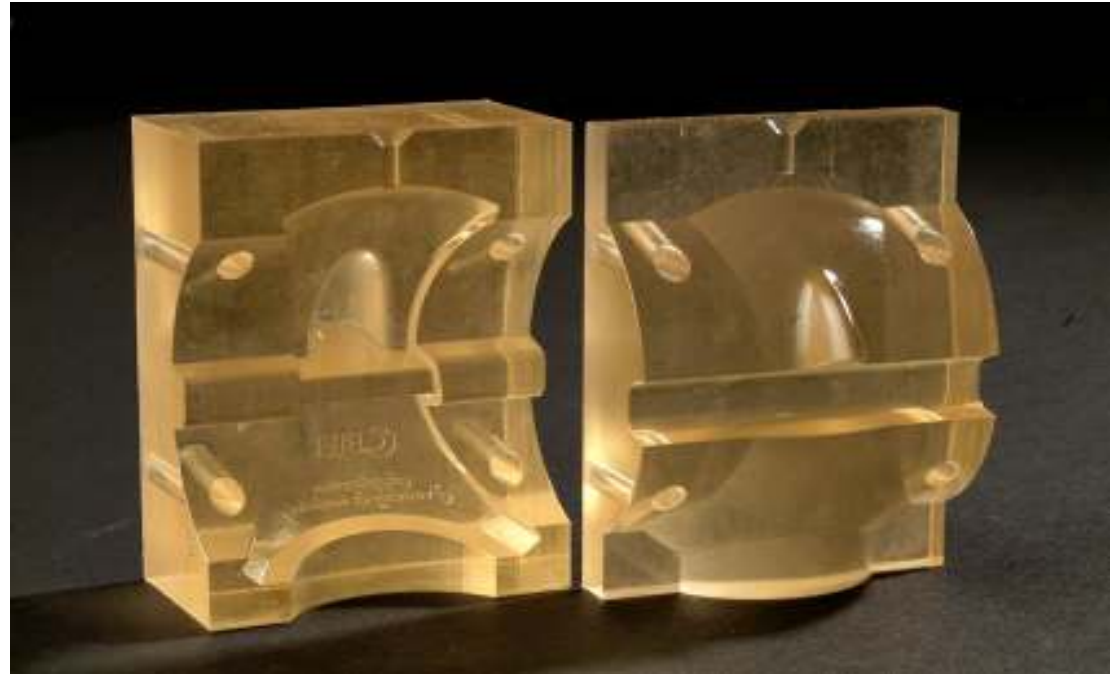
Potlife

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Pros & Cons

Rapid Tool



- Objet/PolyJet and PolyJet Matrix printed moulds for RIM as Rapid Tooling
- Such tools can be designed by MAGICS
- The RIM parts are unlimited – but a proper release agent must be applied

Details of the Tool – 1

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Comparison

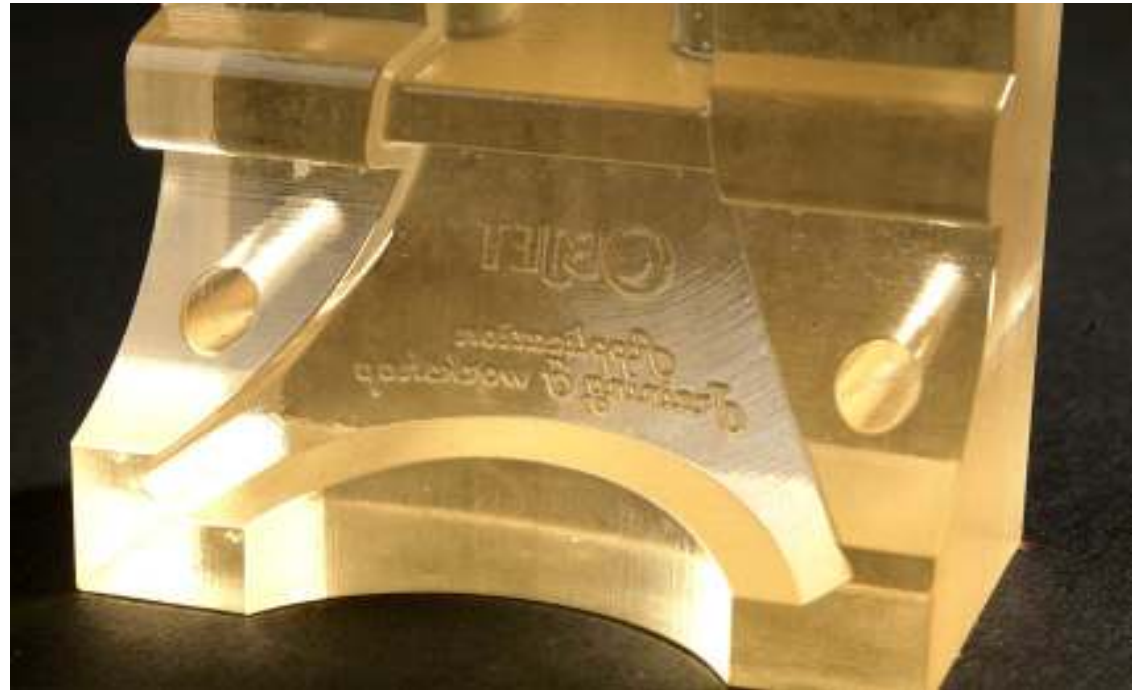
Potlife

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Pros & Cons

Rapid Tool



- A closer detailed picture of the directly printed Rapid Tool for RIM process

Objet & RIM Part

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Rapid Tool



You can see:

- The printed master model for silicon mould
- The RIM part which was made using printed hard tool

Thank You!

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