Molding inserts with XLPE

Part 2 of an on-going investigation

ARM
Annual Meeting
Nov 2015

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Ingenia Polymers

- Supplier of Additive formulations to the resin producers and to the film Packaging industry.
- Supplier of XLPE and other specialty grades to the Rotomolding industry
- 28 years in Business,
  - started pulverizing for Rotomolding

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Why be concerned with Inserts

- 50-75% of XLPE scrap is caused by defects and leaks at inserts and parting lines.

Taking out Art and inserting Science

Systematic approach to understanding the root cause

Developing logical solutions to the problem

I hate mysteries!

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The Challenge

In the Beginning

- This mission started 4 years ago
  - In a land far, far away (India)
  - 45’C in the shade (113’F)
  - 55’C next to the machine (131’F)
- The rotomolder had 2 molds;
  - Both of these molds were causing blow holes at inserts but other molds in the shop were fine!
  - One was old; had wide gaps and loose tolerances
  - The other was new; perfect and tight

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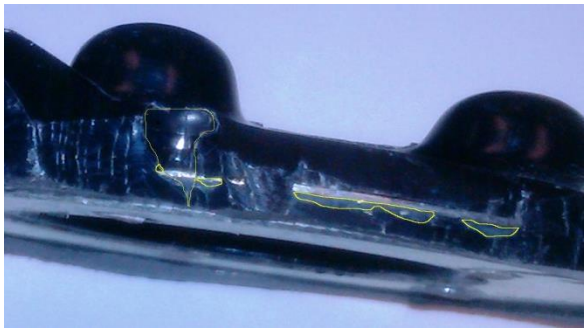
The investigation

What we discovered

(part 1 summary)

- Bridging around insert
- Insert close to side wall
- Large heavy clamp used to attach the inserts
- Gaps at interface of insert and mold



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Solutions/Fixes

What we did!

- Remedies
  - Drill holes behind location of larger insert to vent to outside
  - Reduce heat sink of large clamp
  - Use brass bolt to improve heat transfer
- Logic
  - Air pockets due to bridging or poor fitting of insert cause localized concentration of gasses
  - Slow heating of insert exposes insert to avalanche flow of sticky coarse powder as free-flowing fines have been consumed.
- **Results: dramatic reduction is scrap rate**

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What do we know about Blow Holes

- Occurs late in the rotomolding process
  - At above the melting temperature, XLPE is soft like jello
    - Can easily be deformed by gas expansion
  - Expansion of trapped air bubble
  - Increases in severity/probability at longer cycle time
  - Bursting of bubble to the inside surface

- Not a single cause, complex interactions
  - Resin properties
  - Mold construction/design
  - Rotomolding process quirks.

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PART 2 investigation

What now ?

- Mold construction
  - Location of insert
  - Attachment
  - Heat transfer rate

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Create a complex mold

- Include all the known causes of blow holes into one mold
  - Multiple inserts
    - Various heat sink
    - Spacers
    - Proximity to wall

  - Date stamps with heat sink
  - Drilled holes
  - Various surfaces
    - Shot peen, sand blast, cast aluminium

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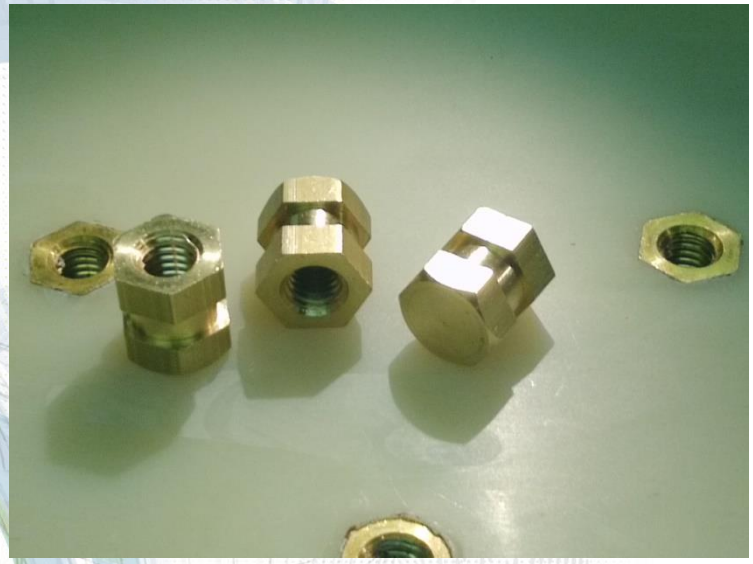

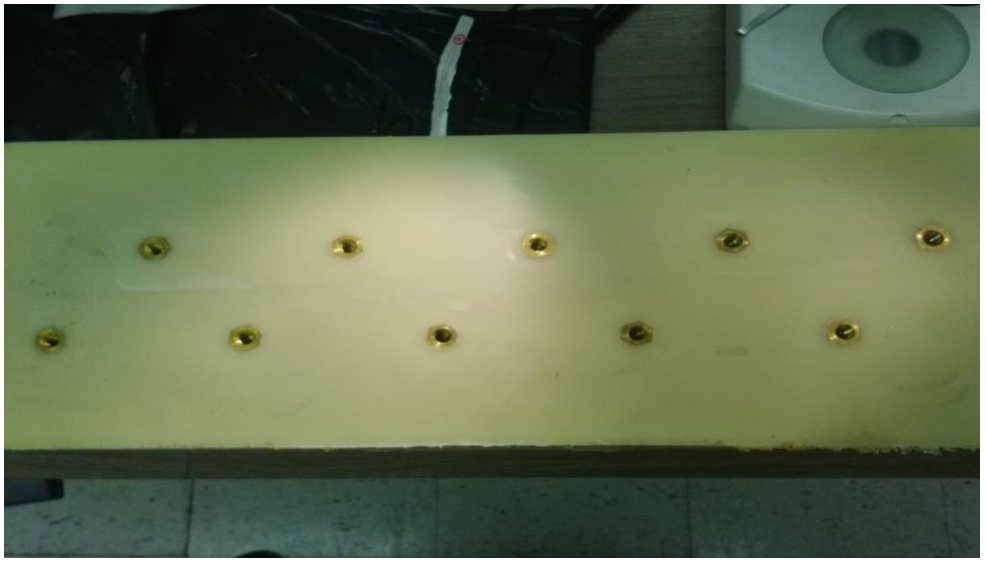

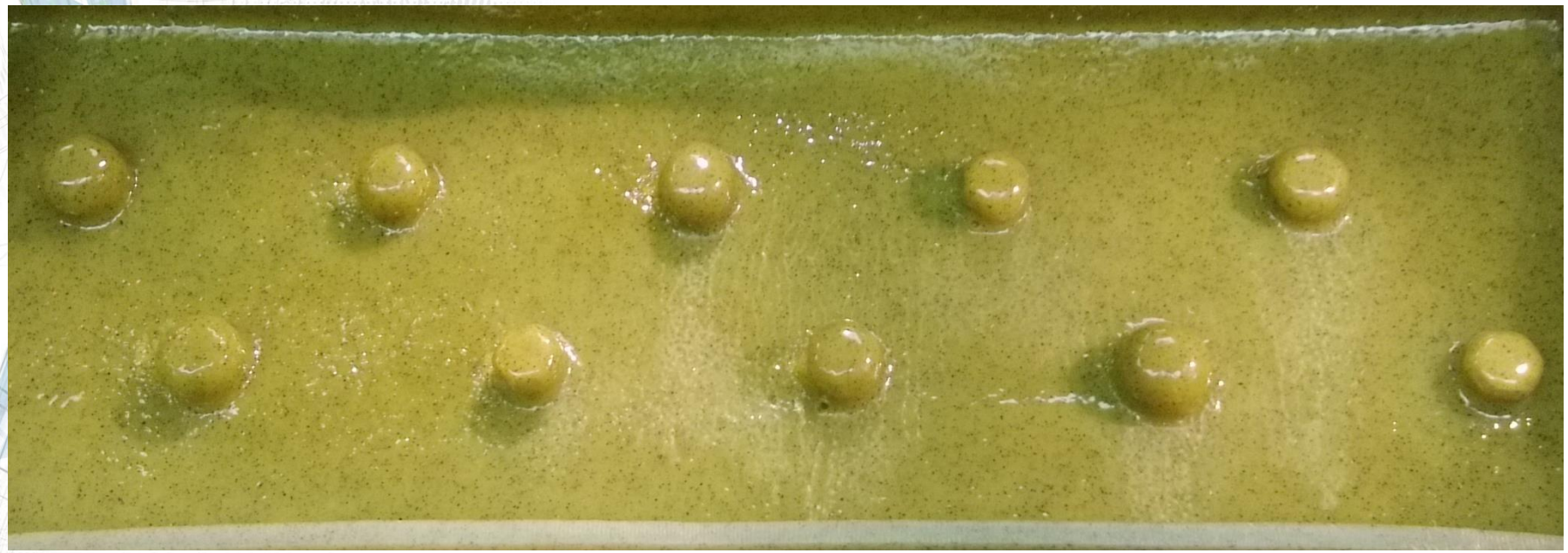

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- **Heat sink**

- Stainless
- Steel
- Aluminium

- Large
- Small

- Bolt
- Brass bolt

Objective:
Create conditions to cause blow holes

Try Again!

- First attempt…
- Standard conditions and PIAT
  - All heat sink tightly attached

- Result: all is good, no blow holes!

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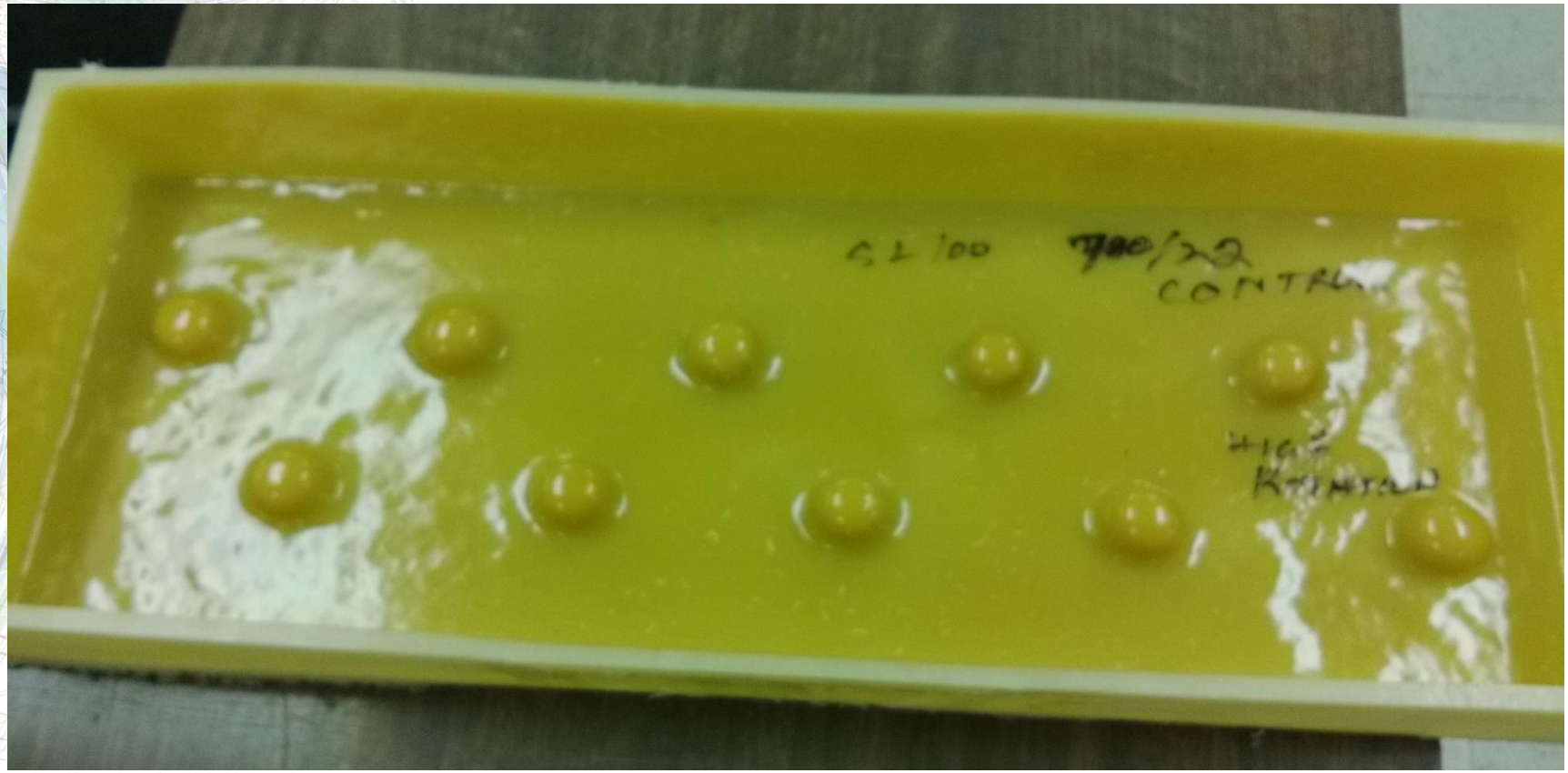
Ok, lets crank up the temperature

- 700’F Still no blow holes, insert coating fairly uniform!



Now add Teflon spacer under insert

- Still no blow holes but obvious difference in coating thickness over inserts.
- (I added a small amount of black powder to assist photography)

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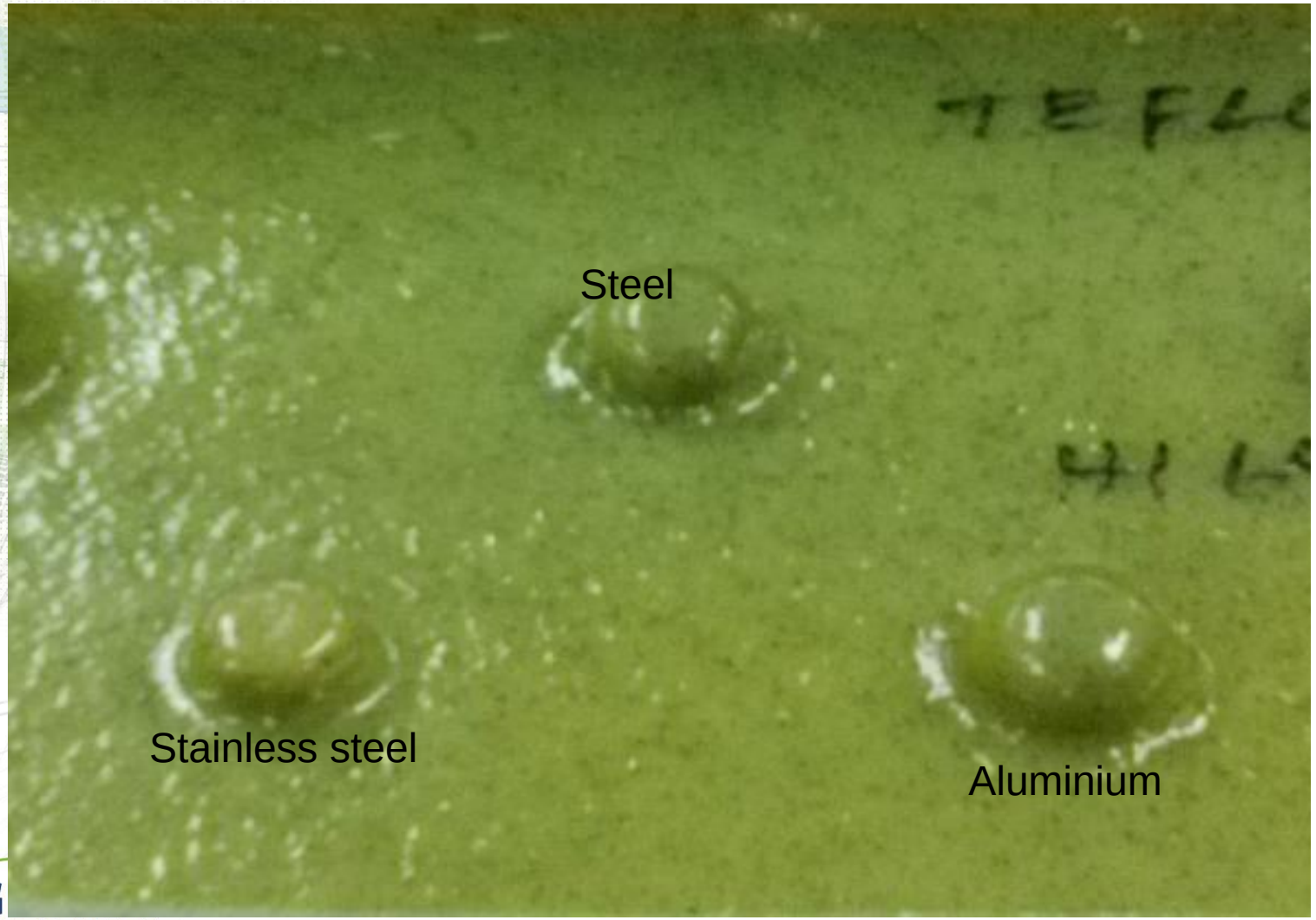
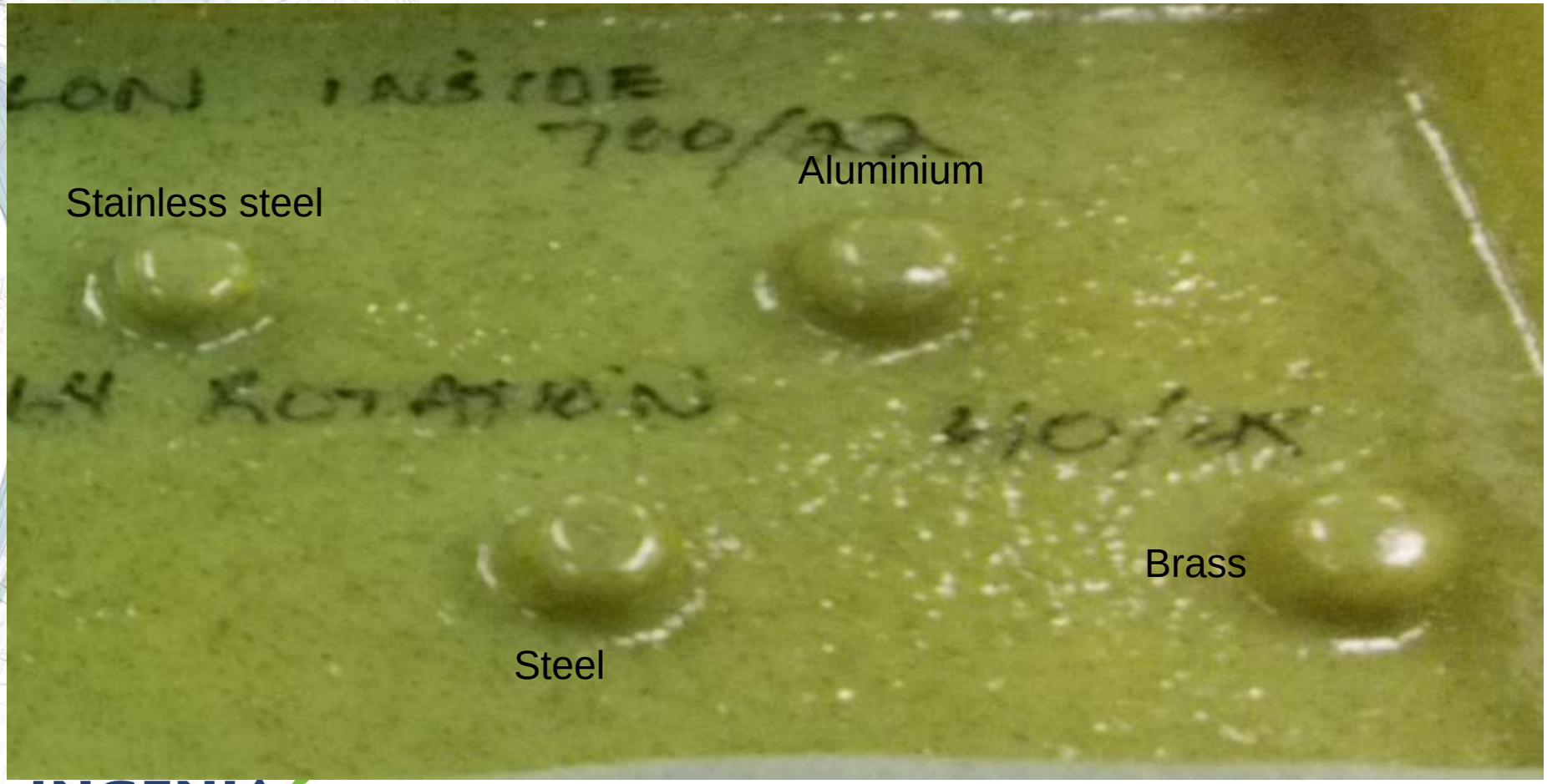
Effect of heat transfer
Large mass, Insert insulated from mold

Effect of heat transfer
Small mass, Insert insulated from mold



Effect of heat transfer
Simple bolt, Insert insulated from mold



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All very interesting but still no blow holes!

- We spent lots of cash on a mold and cant make any defects!
- We tried a powder sifted to sub 70 mesh! No blow holes!
- Ok Lets try to slow down the rotation speed…

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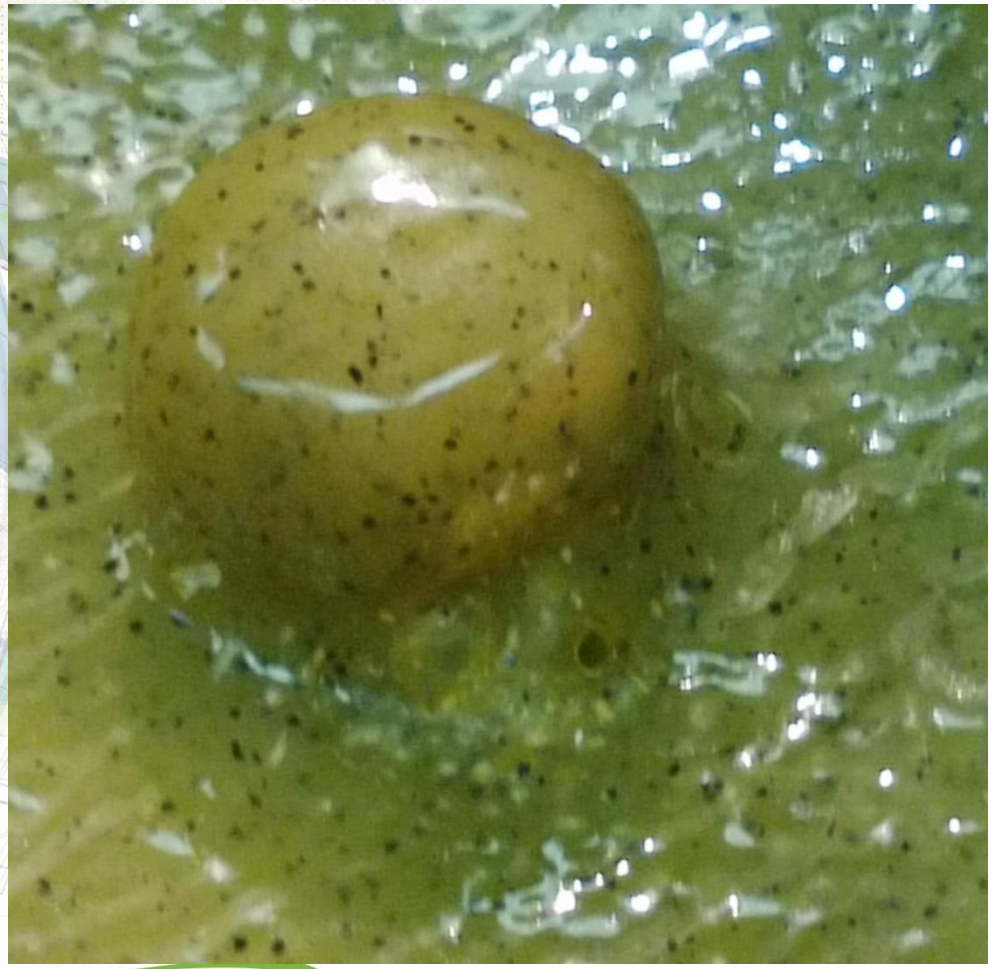
Eureka!



- **We can now create blow holes on command!**

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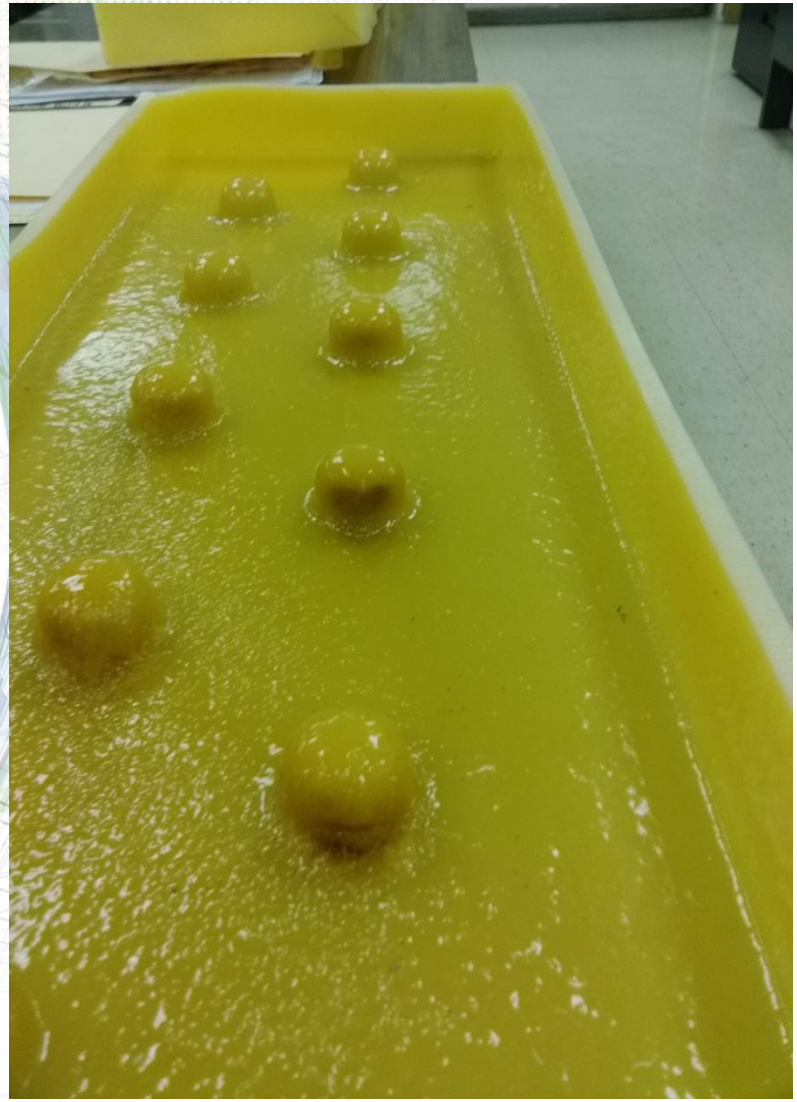
The dark side of the moon !



- The rotation direction is critical
- All blow holes formed on the down-side of flow direction…
- The insert at bottom of box also always poorly filled.

- No conclusion yet on effect of heat sink on blow hole.
- Small mold has different dynamics…

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- But wait !
- Something happened to our cast aluminium surface!

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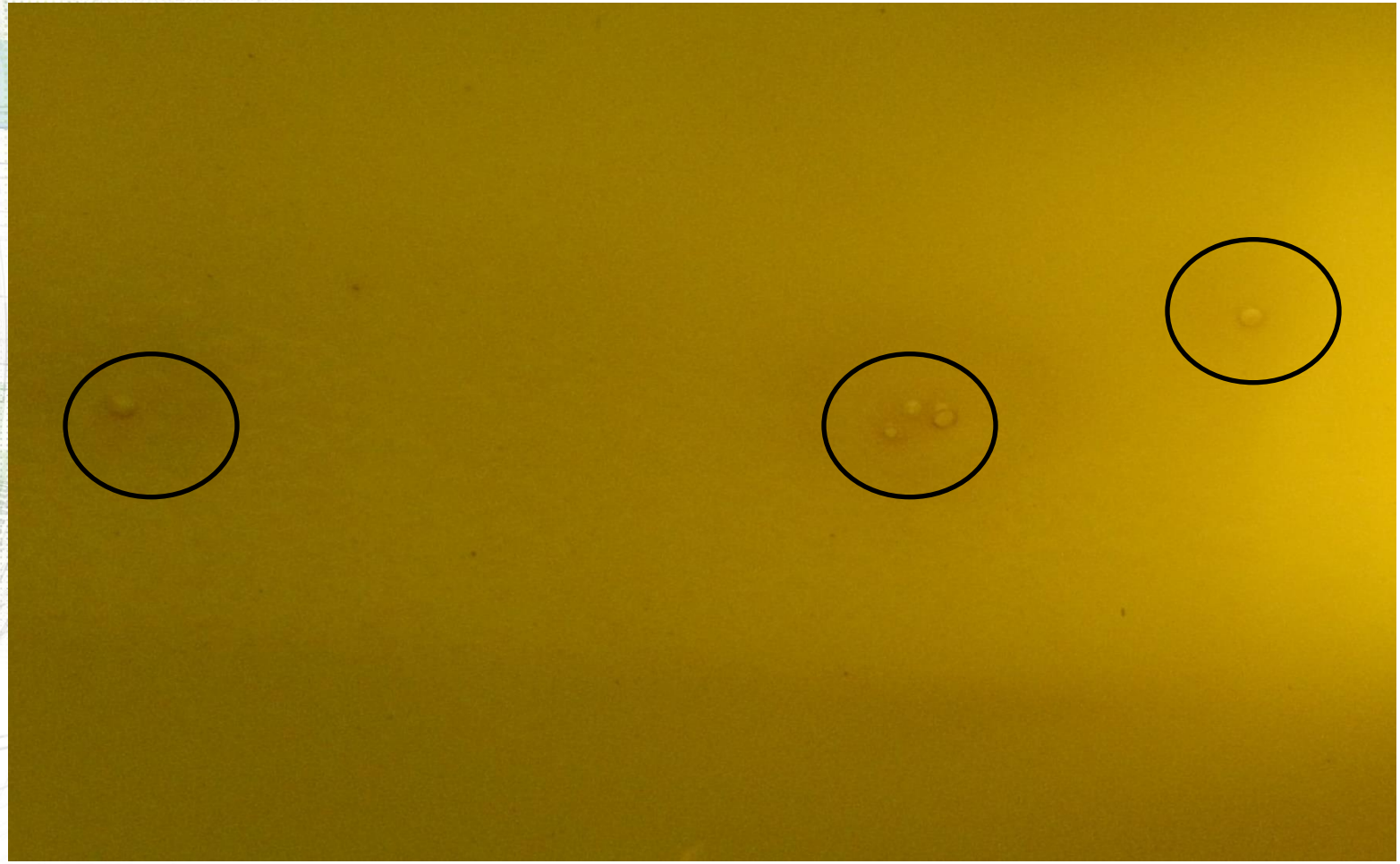
We are now getting blow holes on flat surfaces….



Porous pits cause Blow holes

Conclusion

- Haven’t been able to demonstrate effect of heat sink on blow holes
- Demonstrated dramatic effect of rotation speed on blow holes
- Reversing rotation speed would help in situations where the insert is at the bottom of powder flow
- Cast aluminium can cause blow holes due to porosity

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Continuing work

- Pull strength as a result of coating thickness on insert
- Effect of insulation on inserts
- Simulation of larger mold by varying powder propeties

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I hope this information will:

- add a bit of Science to our Art
- reduce your costs and increase competitiveness.

Thank you

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