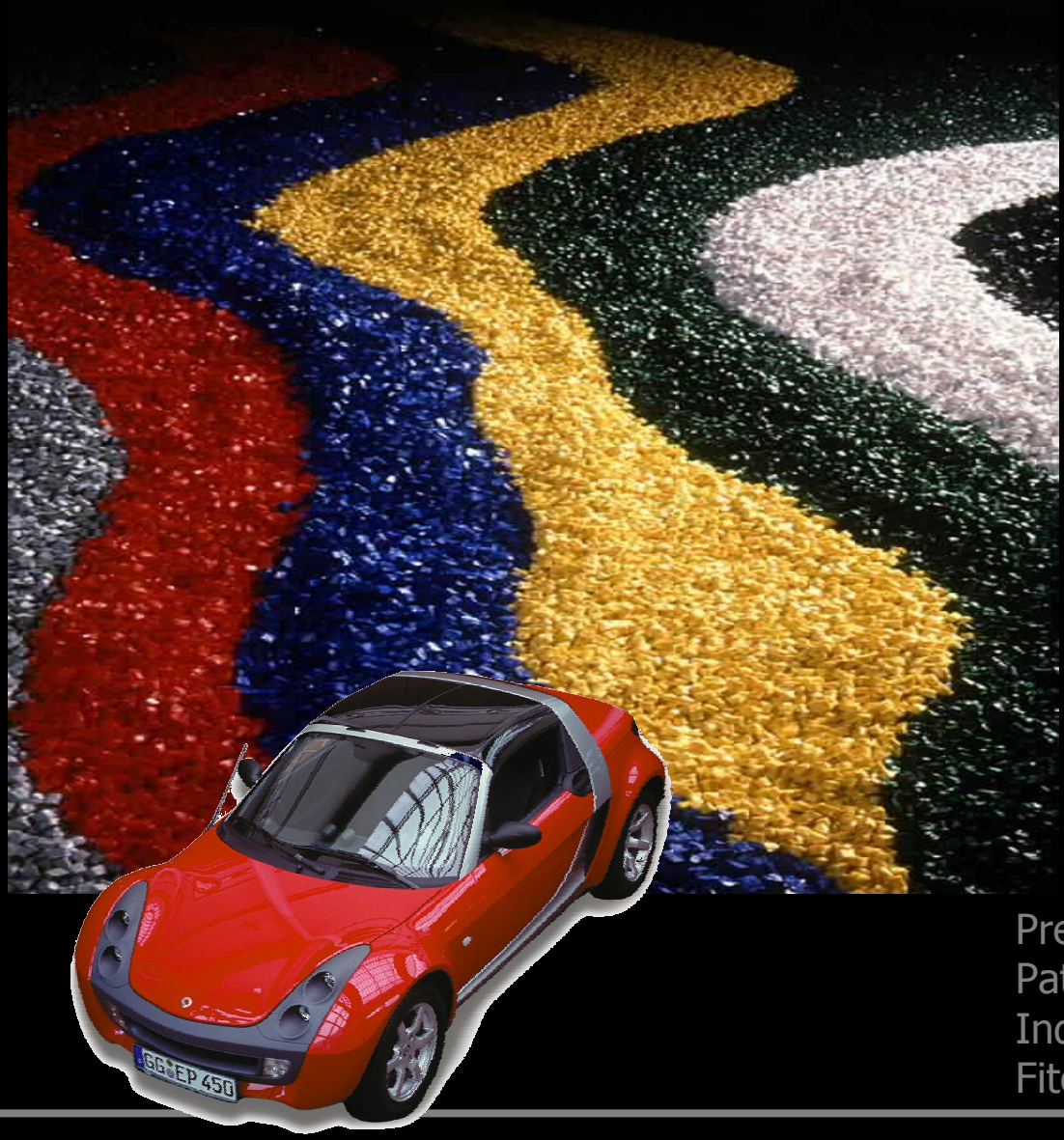
Using Aesthetic Additives in Engineering Thermal Plastics for In Mold Automotive Applications



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Fitch

fitch

Types of Aesthetic Additives in ETP

Molded in effects for Class A surface

- Pigments
- Dyes
- Non-Dispersing Pigments
- Metal Flakes

Benefits of Aesthetic Additives in Automotive

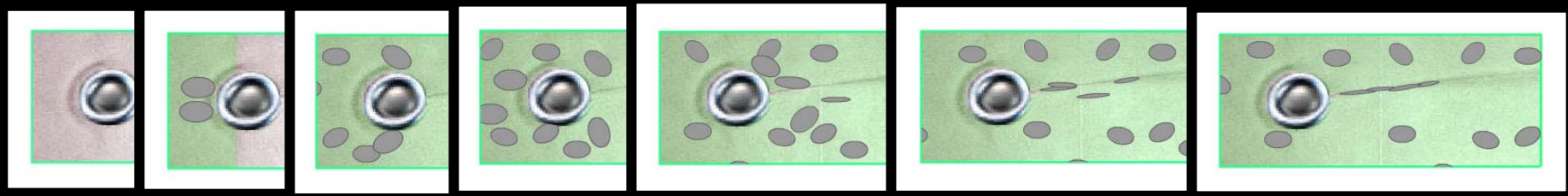
Molded in effects for Class A surface

Increase Customer Market Share by…

- Brand Differentiation
  - Brand signature
  - Aesthetic Elements
  - Trend Elements
- Cost-Out Opportunity
  - No Paint or Platting solution / Environmental issues
  - Maintain Aesthetic intent
- Mass Customization
  - Specialty Vehicles
  - Aftermarket Opportunities
  - High End to Low End Vehicle Versions

Challenges of Molded in Effects

Flow Lines in the Molding Process



The problem is physics:

- To create the metallic effect, very small aluminum flakes are used.
- When they flow in flat areas, they are parallel to the surface, when they go around openings, they turn up on edge.

The reflectance from the flakes on edge is different than from the flat surface of the other flakes.

The result is a black streak on the part.

Challenges of Molded in Effects

Material Property Shifts

Additives can diminish the base resins properties...

Typical Properties	LEXAN 121R Standard	LEXAN FXD121R Diffusion	LEXAN FXM121R Lustre / Sparkle / Ares	LEXAN FXL121R Luminescent	Test Method
Mechanical					
Tensile Stress, Yield, 50 mm/mm	**63 MPa**	**61 Mpa**	**63 Mpa**	**61 Mpa**	ISO 527
Tensile Stress, Break, 50 mm/mm	**65 MPa**	**65 Mpa**	**50 Mpa**	**65 Mpa**	ISO 527
Tensile Strain, Yield, 50 mm/mm	**6%**	**6.20%**	**6%**	**6.20%**	ISO 527
Tensile Strain, Break, 50 mm/mm	**100%**	**125%**	**50%**	**125%**	ISO 527
Tensile Modulus, 1 mm/min	**2350 MPa**	**2400 Mpa**	**2350 Mpa**	**2400 Mpa**	ISO 527
Flexural Strength, Yield, 2 mm/min	**90 MPa**		**90 Mpa**	**93 Mpa**	ISO 178
Flexural Modulus, 2 mm/min	**2300 MPa**	**2380 Mpa**	**2300 Mpa**	**2380 Mpa**	ISO 178
Impact					
Izod Impact, unnotched 80*10*4 +23 C	**NB**		**NB**		ISO 180/1U
Izod Impact, unnotched 80*10*4 -30 C	**NB**		**NB**		ISO 180/1U
Izod Impact, notched 80*10*4 +23 C	**12 kJ/m2**		**10 kJ/m2**		ISO 180/1A
Izod Impact, notched 80*10*4 -30 C	**10 kJ/m2**		**8 kJ/m2**		ISO 180/1A
Charpy 23 C, V-notch Edgew 80*10*4 sp=62mm	**NB**		**10 kJ/m2**		ISO 179/1eU
Charpy -30 C, V-notch Edgew 80*10*4 sp=62mm	**NB**		**8 kJ/m2**		ISO 179/1eU
Instrumented Impact Energy @ peak, 23 C	**62 J**	**72 J**		**72 J**	ASTM D 3763
Thermal					
HDT, 0.45 Mpa, 6.4 mm, unannealed	**138 C**	**135 C**		**138 C**	ASTM D 648
HDT, 1.82 Mpa, 6.4 mm, unannealed	**129 C**	**124 C**		**129 C**	ASTM D 648
HDT/Be, 0.45 Mpa, Edgew 120*10*4 sp=100 mm	**133 C**		**133 C**		ISO 75/Be
HDT/Be, 1.8 Mpa, Edgew 120*10*4 sp=100 mm	**122C**		**122 C**		ISO 75/Ae
Physical					
Specific Gravity	**1.2**	**1.19**	**1.2**	**1.2**	ASTM D 792
Water Absorbtion, 24 hours	**0.15%**	**0.13%**		**0.13%**	ASTM D 570
Mold Shrinkage on Tensile Bar, flow (2)	**0.5 - 0.7%**	**0.5 - 0.7%**	**0.5 - 0.7%**	**0.6 - 0.8%**	ASTM D 955

Automotive Applications

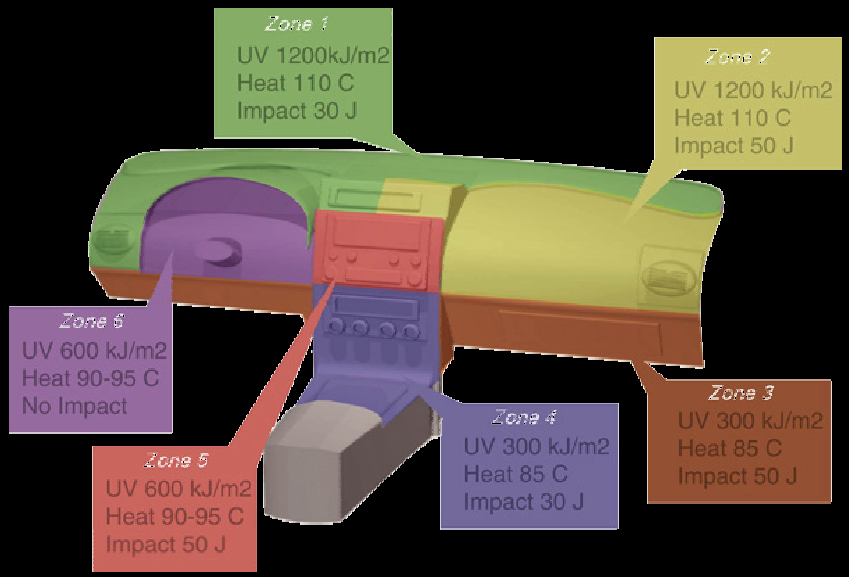
Interior and Exterior

Steering Wheel
Trim
Knobs
Handles
Bezels

Roof Racks
Trim
Lighting Bezels
Handles
Grills
Mirrors

Automotive Applications Requirements

Interior and Exterior



Weathering SAE J 1885
Impact
Scratch
Heat
Chemical

Weathering SAE J 1961
Impact
Scratch
Heat
Chemical

fitch

Design Considerations for Aesthetic ETP

Flow Line Sensitive Additives

Design philosophy will differ depending on effect:

- **Effects achieved with metallic flakes**
  - -Flow Line sensitivity dictates part complexity, gate location
  - -Processing equipment /conditions optimized for minimum shear
  - -Gating location/size dictated by flake size, flow line sensitivity

- **Effects achieved with non-dispersing pigments**
  - -No restrictions on part complexity, gate location.
  - -Standard processing conditions/machinery.
  - -Gate size dictated by filler size.

- **Effects achieved with dyed or conventional pigments-** design philosophy to accommodate translucency
  - -Standard processing conditions/equipment
  - -Tooling for translucent effects need consideration with:
    - Ejector pins, slides, part markings visible
    - Polished “b” may be necessary
    - Gate location dictated by visual appearance

Design Considerations for Aesthetic ETP

Design philosophy for flow line sensitive Metallic Flakes

- **Optimize component break-out to minimize knit lines.**
- **Separate, and take a different design approach with aesthetic and functional parts.**
- **Move assembly features to perimeter of the part.**
- **Avoid sharp transitions in shape and wall thickness to avoid flow line.**
- **Eliminate tooling features protruding into nominal wall.**
- **Consider secondary operations for labels ands logos.**
- **Sample the final texture(s) and wall thickness(s) and approve prior to production tooling.**
- **Selection of base color affects appearance of flow lines (darker is better).**
- **Select the gate size and location based on potential gate blush and flow line creation.**
- **Incorporate the drop in physical properties due to the effects of the metal flake additive in the part design.**
- **End-use requirements and effect will dictate acceptable resin/effect combination.**

Design Considerations for Aesthetic ETP

Design philosophy for translucent and clear Effects

- **Optimize component break-out and take a different design approach with aesthetic and functional parts.**
- **Consider the appearance of the internal components as part of the overall aesthetics.**
- **Select diffuser level, wall thickness, and texture based on desired hiding power.**
- **Color saturation will change with wall thickness.**
- **Texture on primary and inside surfaces must be considered.**
- **Move assembly feature to perimeter of part. (Assembly features will be visible).**
- **Tooling features on the inside of the part will effect overall appearance.**
- **Sample the final diffuser level, texture(s) and wall thickness(s) and approve prior to production tooling.**
- **Select the gate size and location based on aesthetic considerations.**
- **End-use requirements and effect will dictate acceptable resin/effect combination**

Processing Considerations for Aesthetic ETP

Processing Considerations

- Standard Injection Molding Machines may be utilized.
- Tools designed for Engineered materials sufficient.
  - Hardened steel for high volume tools.
  - Inserts in gate areas recommended to prolong life
- Higher Melt and Mold temperatures yield the best aesthetics.
- Low injection speed recommended.
- Low back pressure (<100psi) to maintain fleck integrity.
- Standard Drying and Processing conditions apply.
- Purge machine thoroughly when transitioning to/from effects.
- Follow standard guidelines for regrind usage based on UL & customer guidelines.

Processing Considerations for Aesthetic ETP

Processing Considerations

Screw Design

2.0-2.5-1 compression ratio is recommended. High compression/mixing screws will reduce flake size which changes overall color and appearance of molded parts.
NRV design should be free flowing to avoid unnecessary shear and flake destruction.

Drying

Avoid central dryers and long conveying lines. This will increase clean-up times between production of effects and non-effects codes. Hopper dryers are preferred. Additional cleaning of dryer filters will be required for metallic as aluminum flake may be deposited upon drying.

Processing

Vfx Resins should be processed at upper end of recommended Melt and Mold temperatures. Mold temperatures at 60 -65°C will maximize gloss and reflectivity of aluminum flake filled materials. Unless necessary due to thin walls and long flow lengths, run minimum fill speed to reduce flow disturbances.

Regrind

Regrind may be used at UL maximum of 20% without deterioration of cosmetics or properties. Avoid back pressure over 100 psi.

Processing Considerations for Aesthetic ETP

Tooling Considerations

Gates

- Minimize number of gates - more gates, more flow/weld lines
- Location is critical - do not position gate flow directly into pin or other obstruction
- Size of gate should be minimum 3X the largest pigment/flake diameter
- Shape - fan gates are preferred as they disperse material more evenly

Other

Wear - aluminum flake pigments are soft and deform in gates. Steel quality of tool and slides/cores to be identical, HRC > 52, around gate area a hardness above 55 HRC is recommended

Texture - extremely critical in applications where surface finishes other than high polish are planned. Process "final" approved color into proposed texture before commercialization. A highly polished surface (roughness < 0.1 um) is needed to obtain brilliant gloss levels.

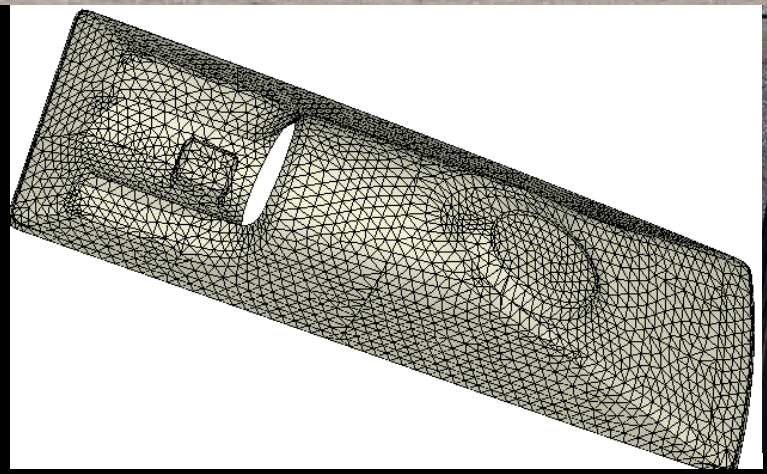
Bosses/Ribs/Holes - all represent flow disrupters and maintaining extremely tight design rigor will improve cosmetics. When ribs, bosses cannot be avoided, use thicknesses lower than half of the wall thickness. Also, keep core pin engagement to a minimum to ensure minimal flow disturbance. (or: rib/wall thickness ratio 1 : 2 max.).

Thickness - -follow normal recommendations of gating from thick to thin walls.

Shrinkage - same mold shrinkage vs. non-effect grades

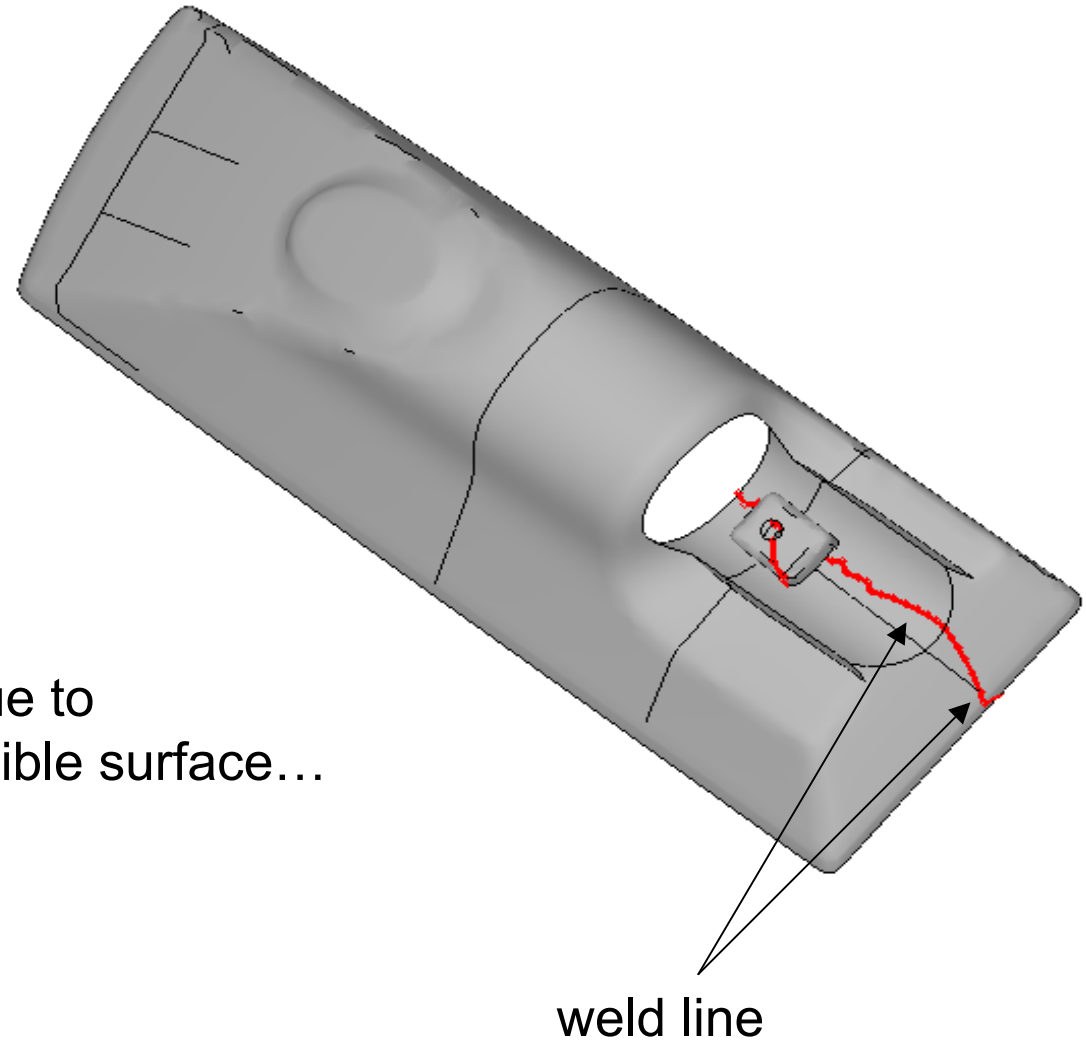
Venting - ensure adequate venting, as in non-effect grade.

Nissan Quest Roof Rack Support Case Study



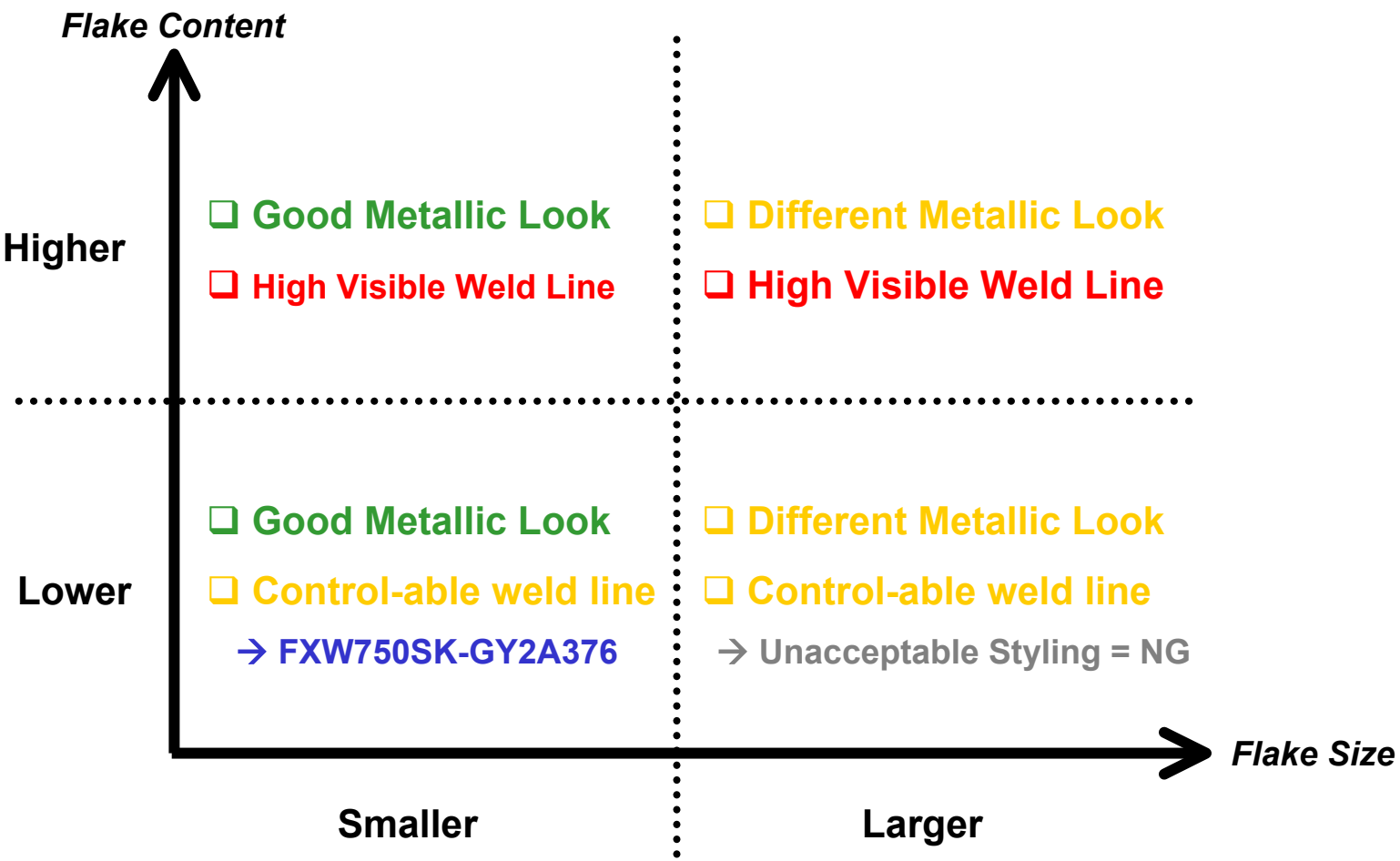
GEAM Geloy® Visual*fx*®

Before



The part had been painted due to unacceptable weld line on visible surface…

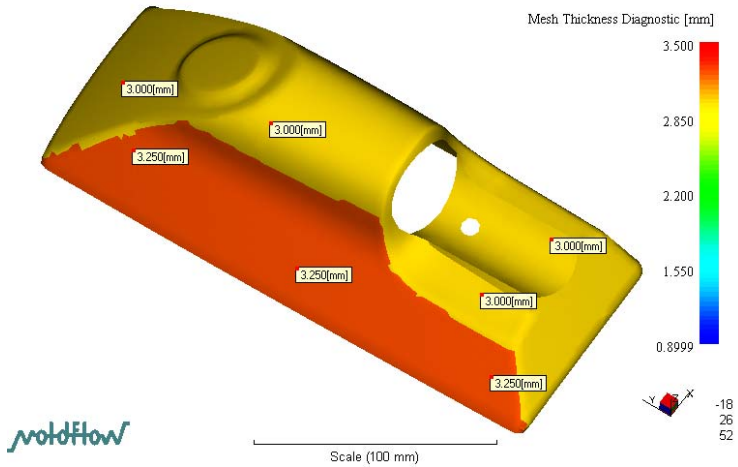
Material Design - Metallic Flake discussion -

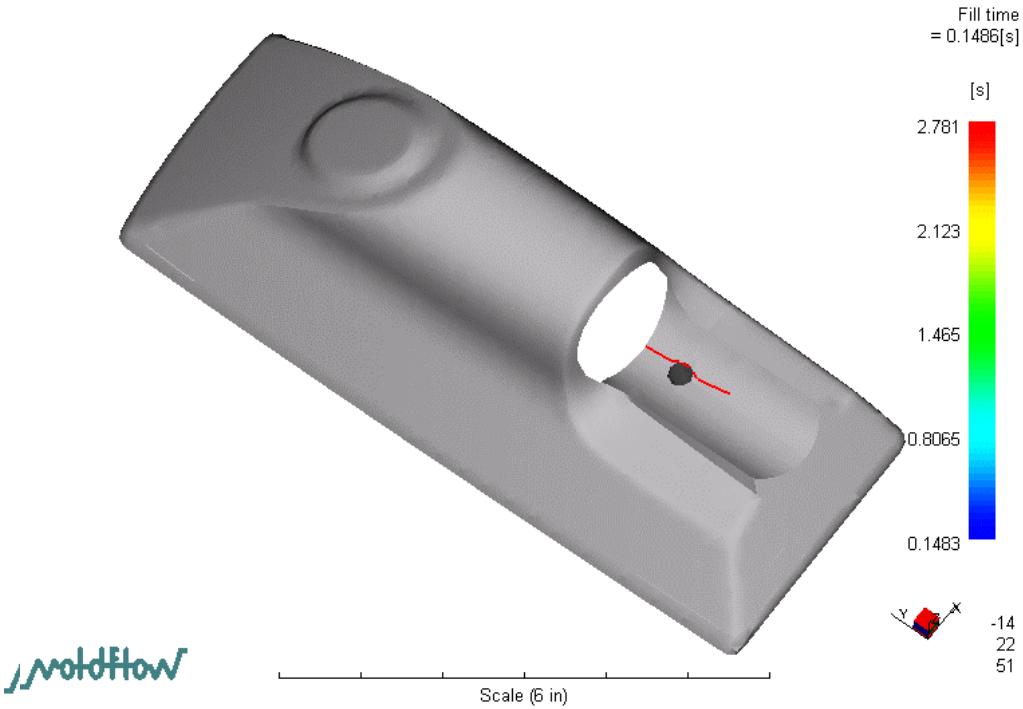


NTCNA choose Lower content and Smaller flake combination

After

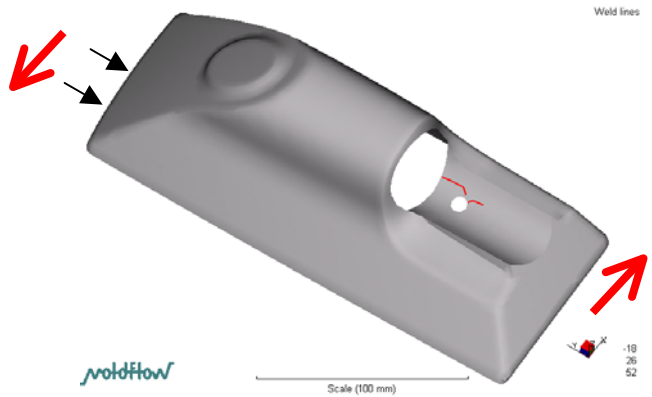
1. Add thickness 0.25 mm as flow leader





2. Change gate location

to lead material flow to invisible side



Switch on slide show to view fill animation

Success to Change Weld Line Direction to Invisible side