Fabrication of Lightweight Aluminium Metal matrix composites and validation IN Green vehicles

The Circular Metal for Future Mobility: Aluminium for lightweight and sustainability

5. GV - Advanced light materials and their production processes

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under the grand agreement number 101007011

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QUESTIONS?

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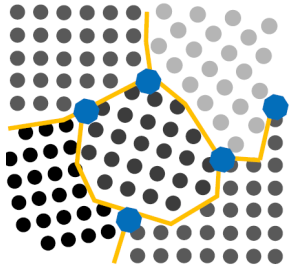
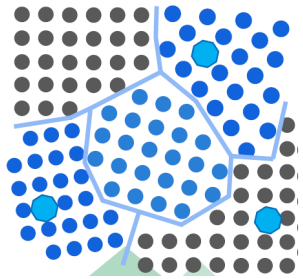
WHY?

- **To Exploit a "different" Strengthening Mechanism**



Hall-Patch $\sigma_y = \sigma_0 + \frac{\kappa_y}{\sqrt{d}}$

σ_y: yields stress
σ_0: materials constant
κ_y: strengthening coefficient
d: average grain size diameter

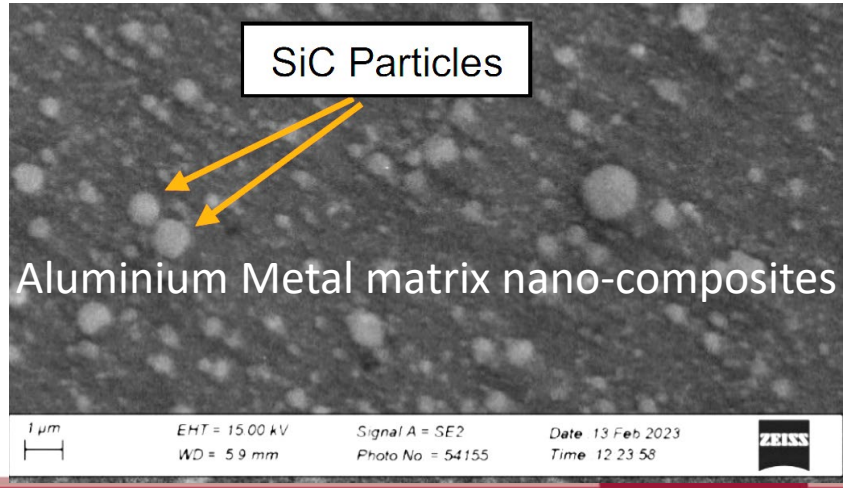


Further strengthening mechanisms:
Immiscible alloys (Fe/Cu – W/Cu – Cr/Cu…)

Nanoparticles and nanoprecipitates in the grains (Orowan)

These are mechanism already exploited in aluminium alloys, but via formation of intermetallics during special TT

- To be less dependant on alloy compositions (i.e. CRM)
- To Compete with Steel on more car components



HOW?

- NANOparticles should be easy to disperse
  - With similar density
  - With good wettability
  - With good stability in molten Al
- NANOparticles should be safe

Pre-Dispersed and Concentrated ADDITIVEs

- NANOparticles should be affordable
- The New Aluminium Metal Matrix Nanocomposite should be recyclable

Expendable SiC TiC Al2O3

3. Technologies of FLAMINGo

HOW?

Nanoparticles & Al Masterbatches

Topology Optimisation

Primary & Secondary Aluminium

Foundry

DC casting
Extrusion

GSC
LPDC
HPDC

Field Test

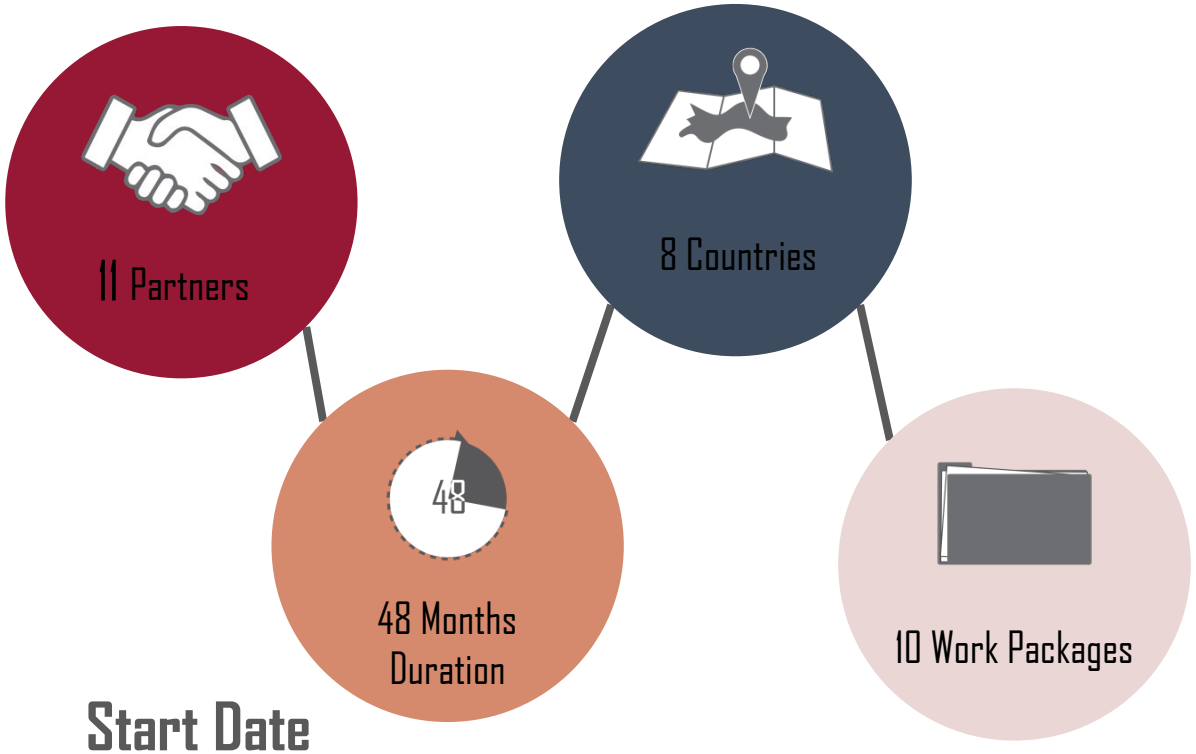
Recycling

Safety

LCA/LCCA

Circularity and environmental sustainability

1. Overview of FLAMINGo



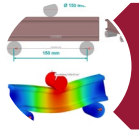
Start Date
1 February 2021

End Date
31 January 2025

1. Overview of FLAMINGo


Metal Alloying with solid-state milling


Low Pressure Die Casting and Green Sand Casting


Topology optimisation


Extrusion


Welding


NDT


Recycling

TECHNOLOGIES INVOLVED

ACTIVITIES SUPPORTING RESULT

- IP Management
- Training
- LCA and LCCA
- Standardization
- Regulation monitoring
- Dissemination
- Communication

2. Objectives of FLAMINGo

- The production of Al-MMnC additives via **solid-state mechanical alloying**.
- The casting of Al-MMnC components by inoculating the **additives in an aluminium melt** and homogenized by ultrasonication and stirring systems.
- The production of smaller components (brackets and connectors) by Low-Pressure **Die Casting** (LPDC) and bigger components (subframes) by Green Sand Casting to demonstrate broader feasibility and applicability of Al-MMnC.
- The **extrusion** of cast billets for making profiles for the body frame.

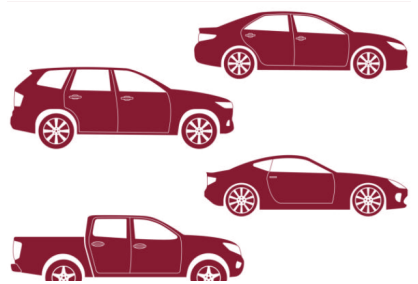
2. Objectives of FLAMINGo

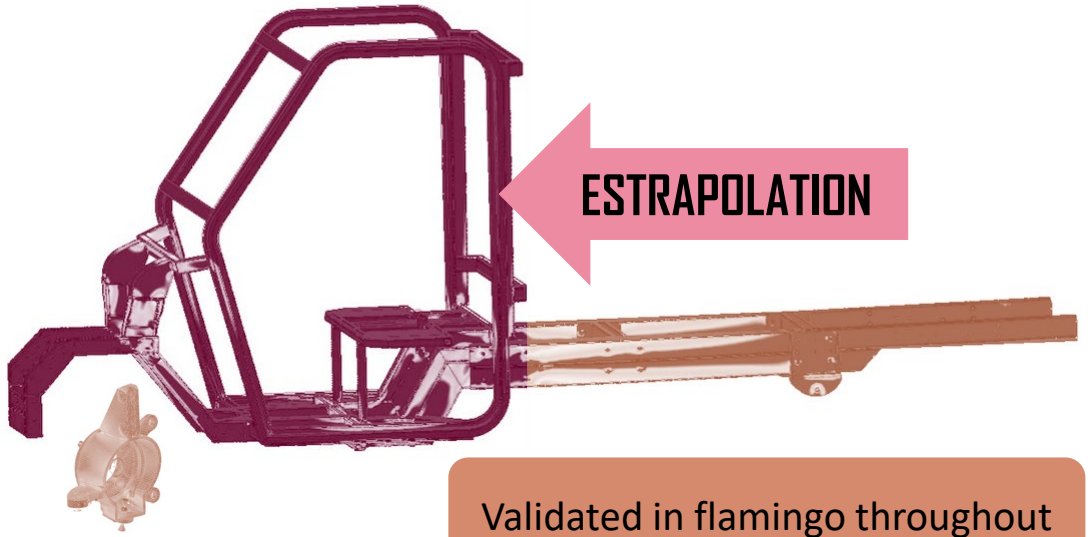
- The **weldability assessment** of Al-MMnC using a range of welding technologies (MIG, resistance spot, and arc stud welding processes).
- The **topology optimisation**/process simulation enabling the reduction of material per part without losing mechanical performances.
- The usage of these components for **substitution of steel** and aluminium parts in electric vehicles, validation of components estimated service life, and installation on vehicles.
- **Validation of recycling** of Al-MMnC components supported also by the use of secondary aluminium in the formulation.

3. Testing of FLAMINGo

Extrapolation Exercise

- To Entire ALKÈ vehicle
- To vehicle representative of other car segments
- Target 3€/kg saved





Weight Saving at component level:

Steering Knuckle	Rear Frame
-58wt.% -31wt.%	-35wt.%

Validated in flamingo throughout the entire life-cycle

FLAMINGO
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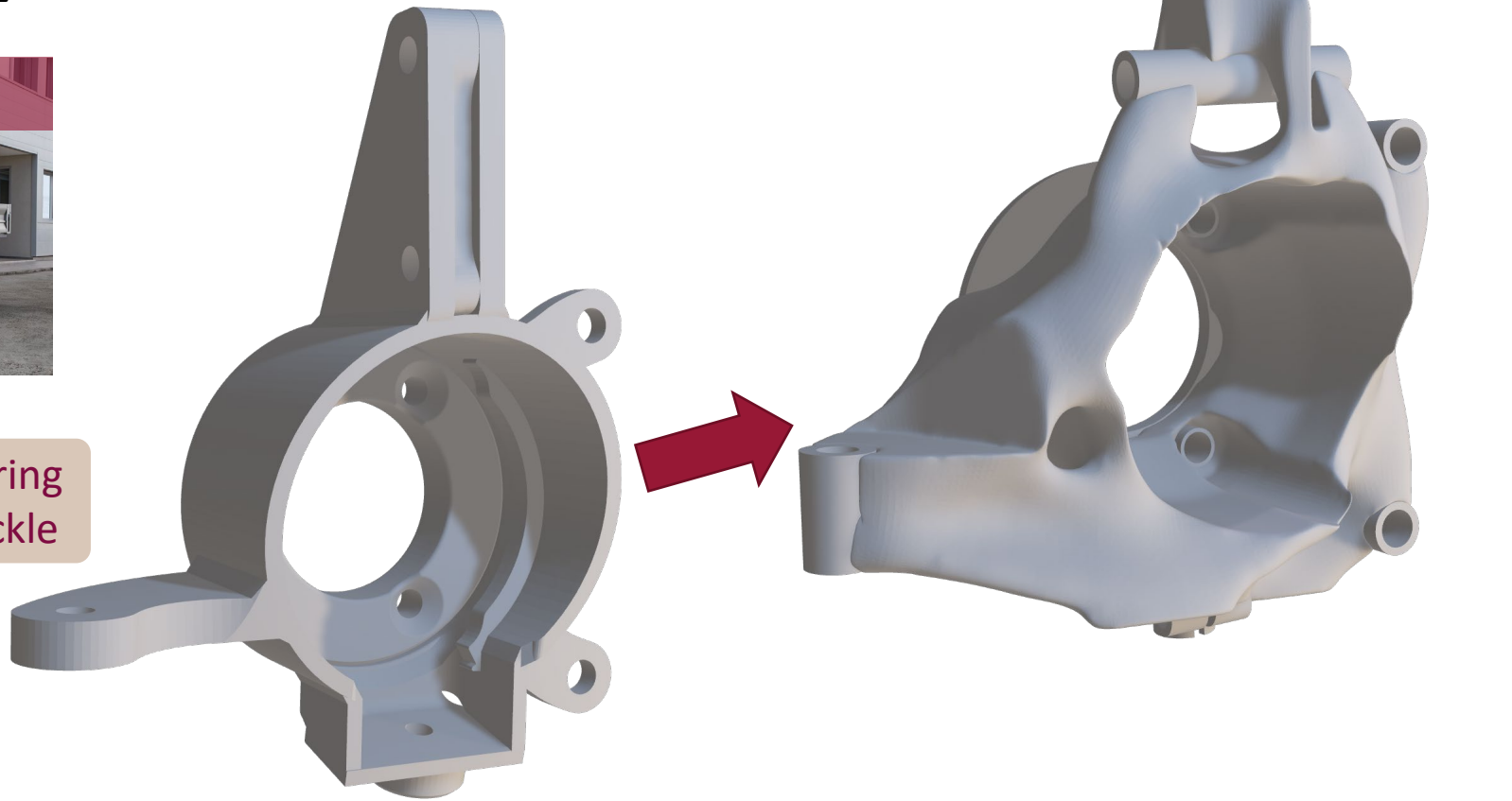
Approach and Methodology

- The FLAMINGO project has a duration of 48 months and will comprise of the following phase:
  - **Phase 1:** Identification of nanoparticles/alloy combination
  - **Phase 2**: Development of dispersion and casting technologies
  - **Phase 3**: Topology Optimization of the component
  - **Phase 4:** Characterization and use
  - **Phase 5**: Recycing of the Al-MMnC

Steering Knuckle



5. Preliminary results

	Alloy/Masterbatch	YS (MPa)	UTS (MPa)	El (%)	E (Gpa)
Al-MMnC for LPDC and Green Sand Casting	3xx series +T6	+10 to +30%	+12 to +35%	≈	-
Al-MMnC for Extrusion	6xxx serie	+8 to +20%	+10%	-30%	+6%

Maximising results

Aluminum Recycling is an established process that FLAMINGo will comply with

Recognition of the new material and mathodologies

Guidelines for forming (Extrusion, Casting) and assembly (Welding) always considering Nano-safety

Assessment of Methodologies for the evaluation of new components

IMPACT OF FLAMINGO

SHORT TERM IMPACT AT VEHICLE LEVEL

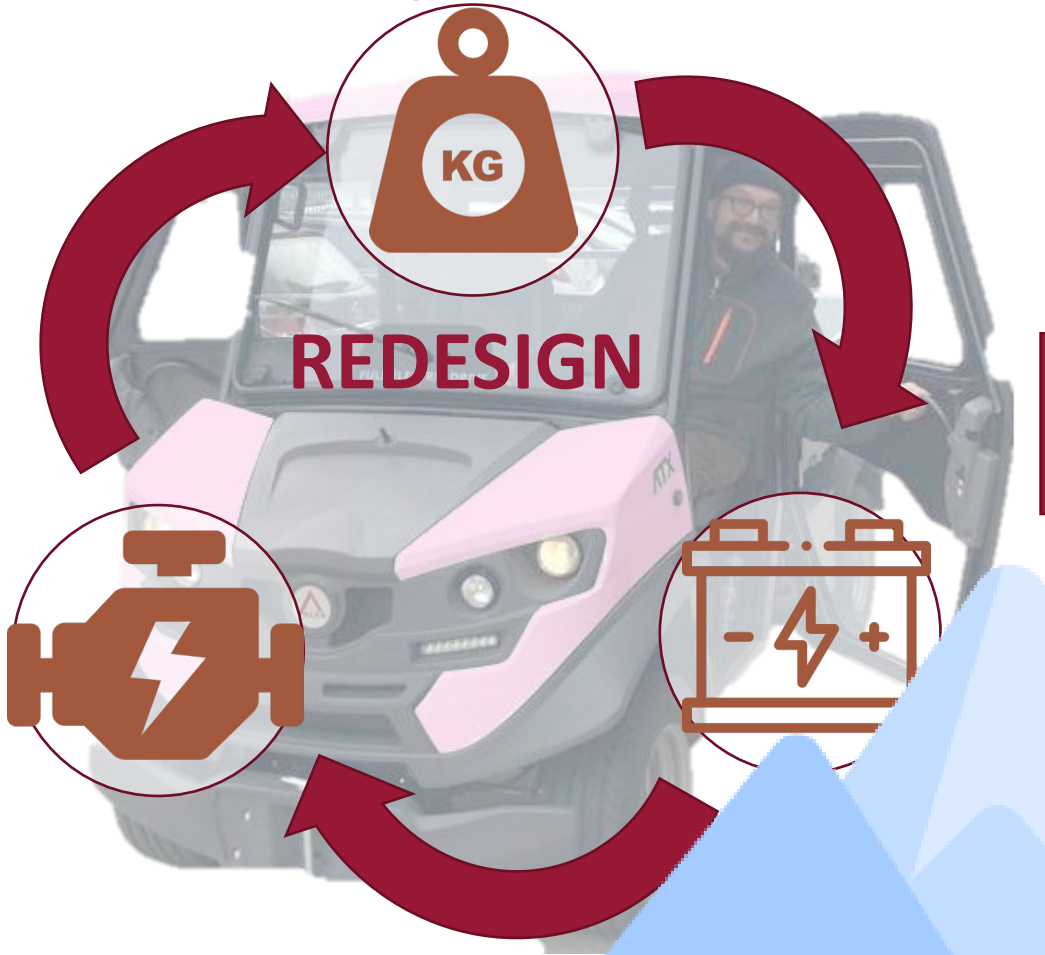
More Off-Road Capabilities

Enable more function. in Utility Vehicles

Increase the working area of the fleet

Enable more flexibility in vehicle configuration

MEDIUM TERM IMPACT AT VEHICLE LEVEL



IMPACT Of FLAMINGo

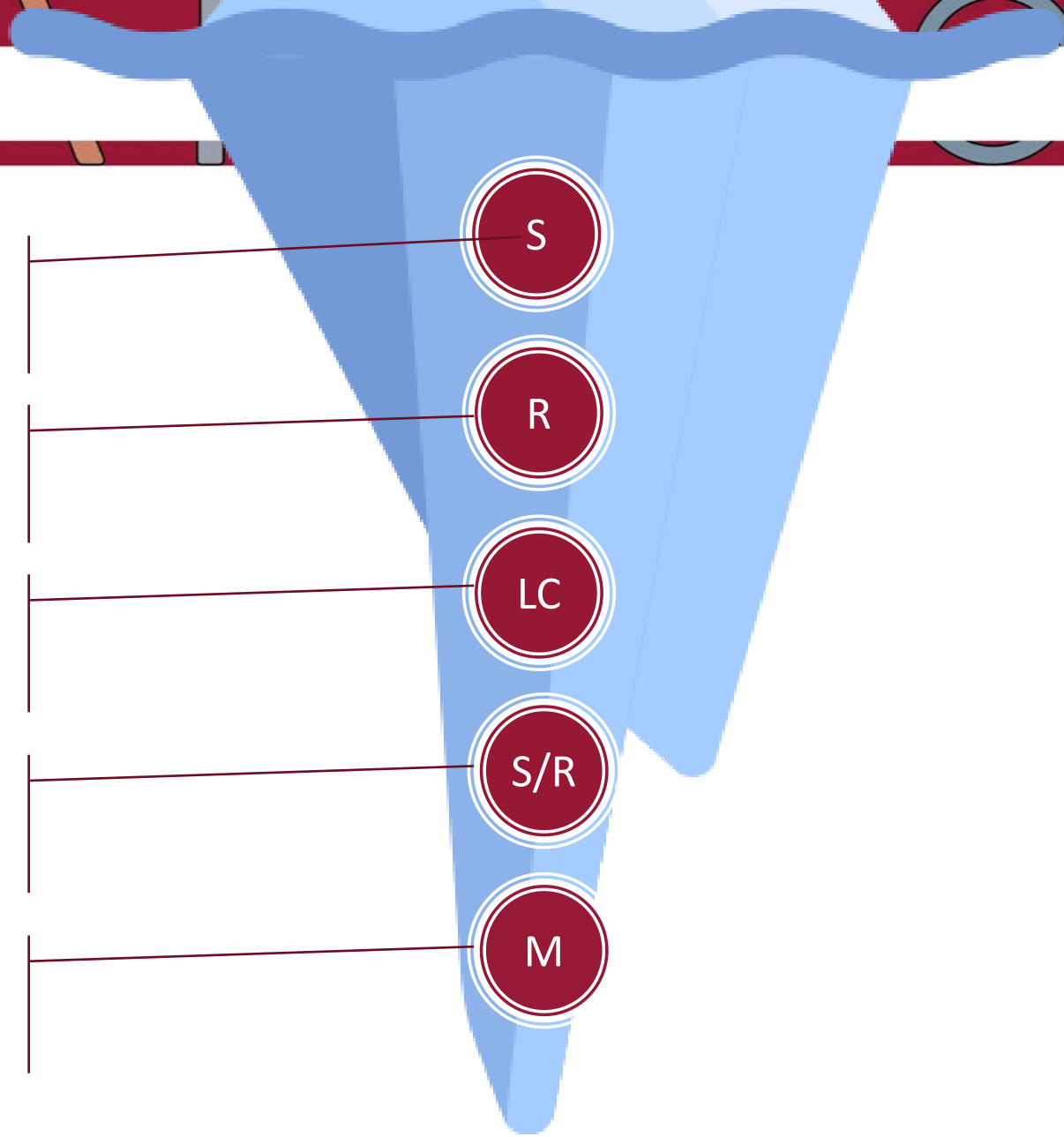
To Establish Guidelines for workers using Nanoparticles-enabled materials

To Establish Guidelines Recycling in compliance with current Aluminum **R**ecycling practices

To Provide the automotive industry with wider portfolio of sustainable material

To support standard and regulation to include Aluminum Metal Matrix nano-Composite

Manufacturing guidelines for better replicability (Casting and Welding in particular)



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