



*Winterthur Gas & Diesel*



**HERCULES-2**

# Work Package 3: Intermetallics and advanced materials for marine engines

Work package leader:

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**HERCULES-2**

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## Objectives

### **Subproject 3.1: *Novel materials for engine applications***

Examine possibilities of using novel materials in engines to facilitate the development of components that enable higher engine loads, hereby increasing efficiency and lower emissions. Ensure proper lifetime performance and durability.

### **Subproject 3.2: *Novel materials for turbine casing***

Material of turbine casing is reviewed in respect of material and design in order to meet requirements needed for higher exhaust gas temperatures.

## Expected outcome

**Subproject 3.1:** Suitable new materials can be identified for at least two components for higher load operations and longer life time.

**Subproject 3.2:** Performance is improved through material / design optimization.

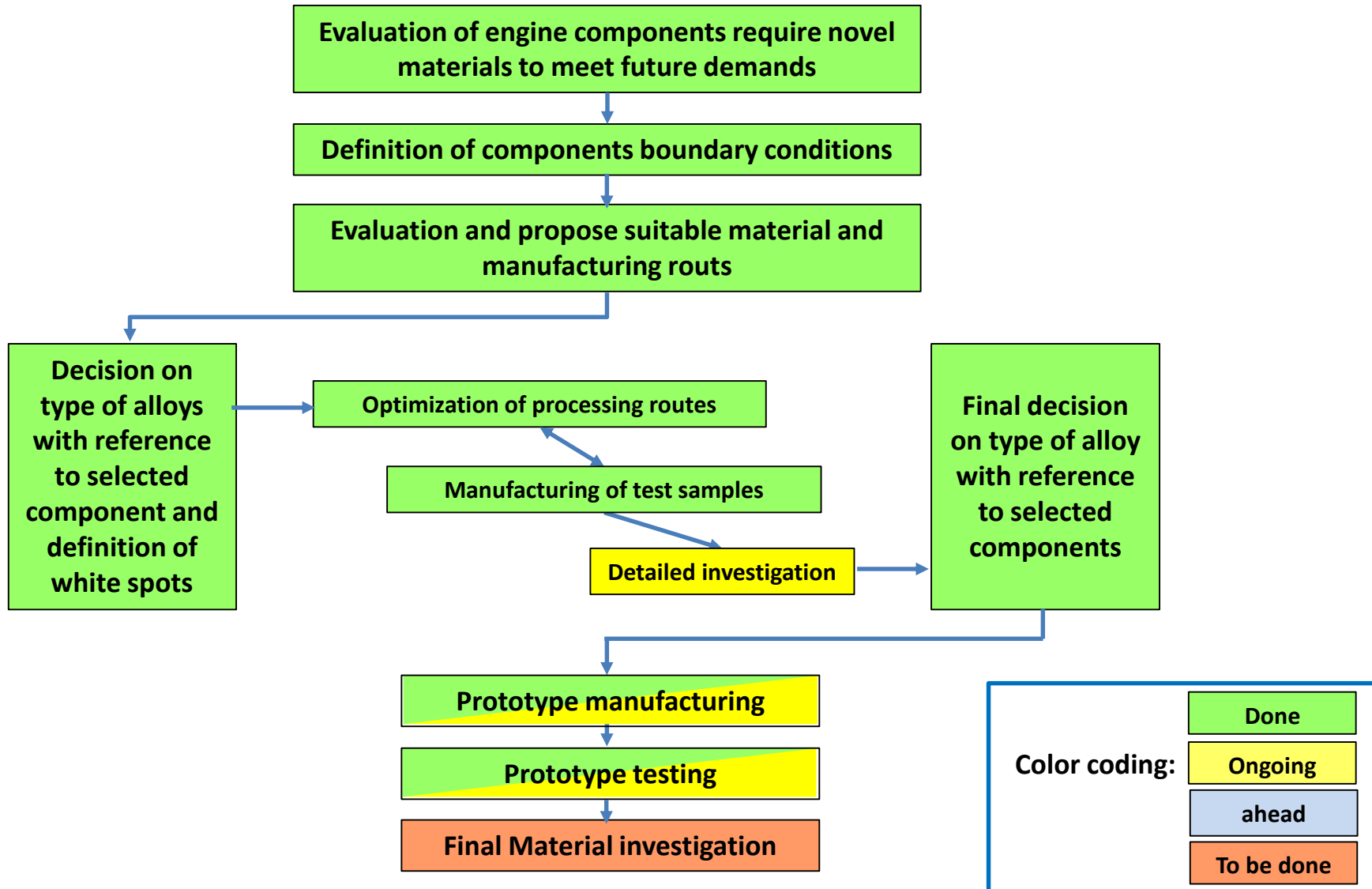
Partners:



Deloro  
Wear Solutions



## Status of Sub-project 3.1: Novel materials for engine application



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### *Status of different tests:*



High temperature corrosion studies  
XPS investigation on passivation behaviour



Tribo testing – outcome still pending  
Shear testing of coatings

### *Status of Prototype manufacturing*



HIP-bars (from new powder batch)  
Prototypes machined from as-casted blocks  
Successfully applying powder of alloy-2 as coating



Machining trails on investment casted blanks  
Machining prototypes from HIP-bars

## Status of Sub-project 3.1: Novel materials for engine application

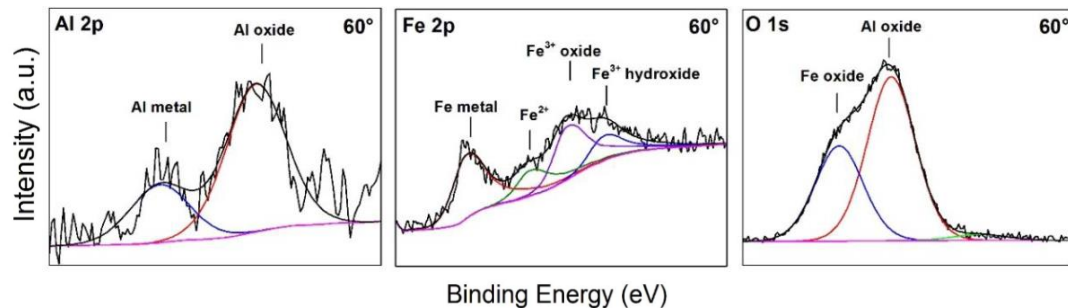
### Selected test results from material characterisation done:

High temperature corrosion studies



*Samples of the investigated materials after high temperature corrosion testing in a vanadium containing salt solution.*

XPS investigations  
(wet corrosion)

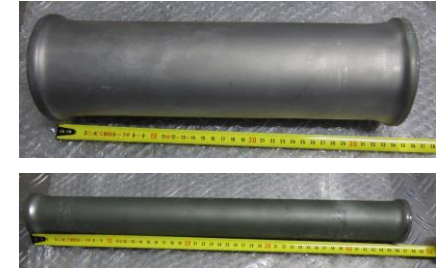
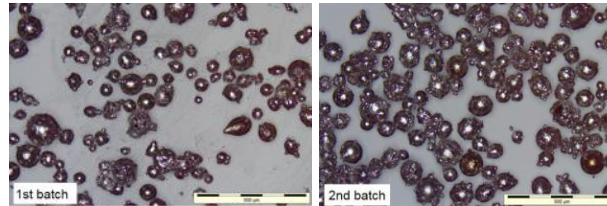


*Examples of the XPS measurements in order to understand the passivation behaviour of the alloys during wet corrosion (alloy 2)*

## Status of Sub-project 3.1: Novel materials for engine application

Prototype manufacturing ongoing:

HIP-bars (from new powder batch)

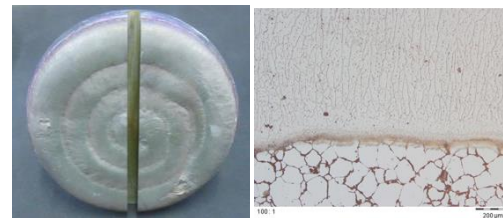


Prototypes machined from blocks

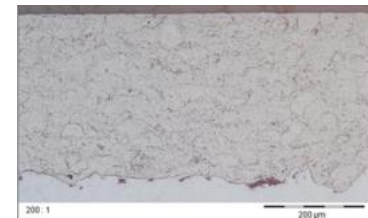


Applying powder of Alloy-2 as coating  
(using different techniques)

Coating 1



Coating 2



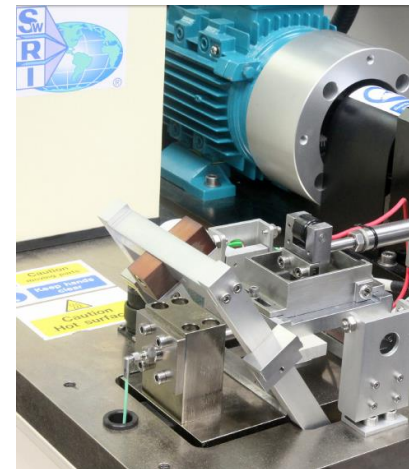
## Status of Sub-project 3.1: Novel materials for engine application



### Planned next activities:

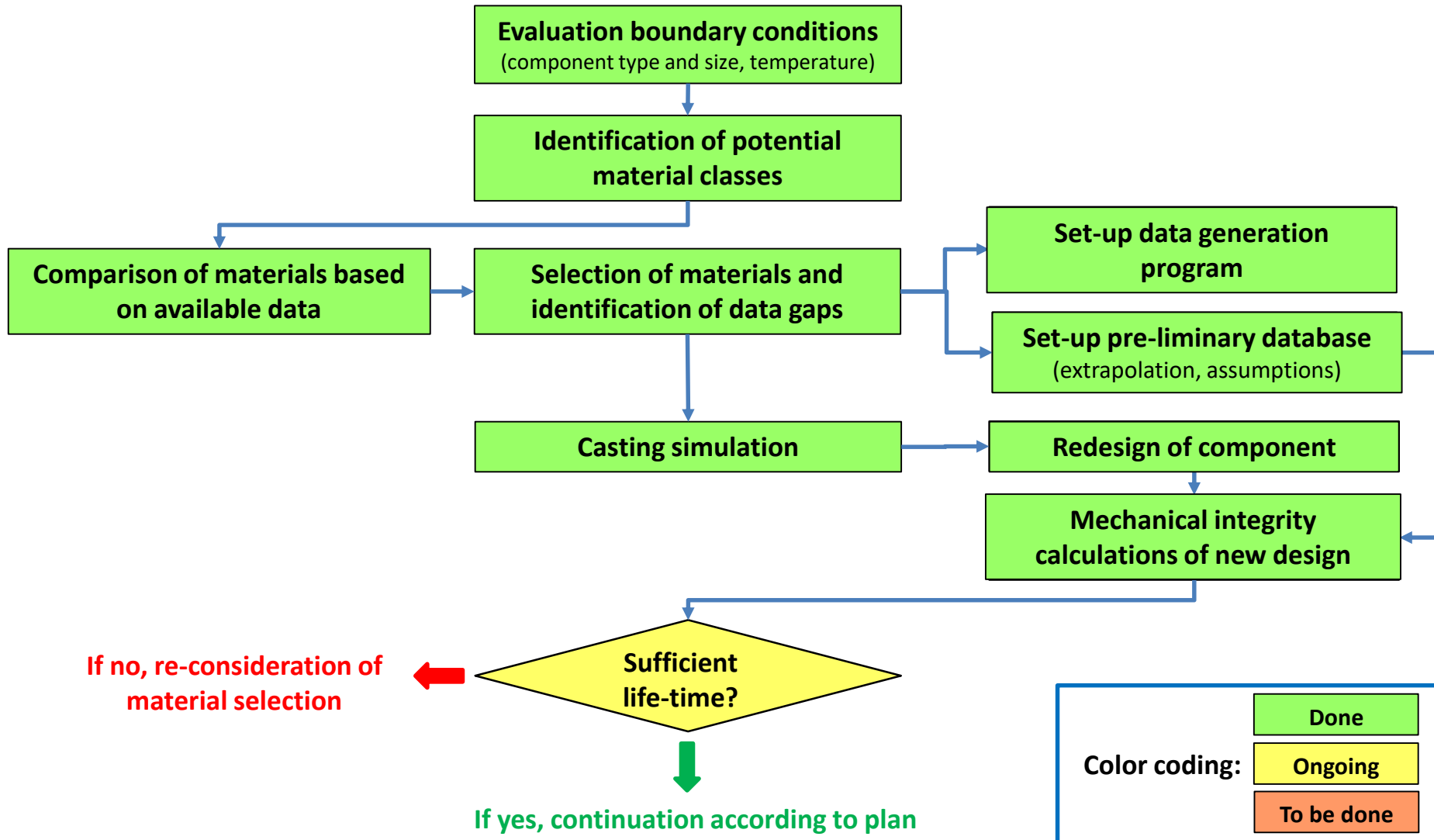
- Finalising tribo testing & sample evaluation
- Investigation on the bonding strength of the coatings made of Alloy2 compared to reference
- Machineability trails of the investment cast blanks
- Manufacturing of prototypes from HIP-bar
- Testing of pre-chambers (4-stroke) made from as-cast blanks

Rig and engine testing to commence in Q2/2018



*Tribo tester: CPT*

## Status of Sub-project 3.2: Novel materials for turbine casing





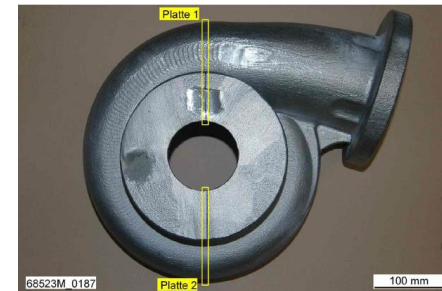
## Status of Sub-project 3.2: Novel materials for turbine casing

### Material testing of as-casted prototypes:

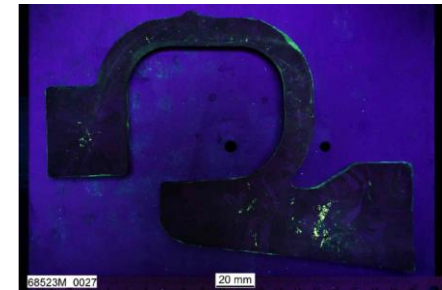
- Non-destructive and destructive quality assurance testing showed that the microstructure and the properties in most regions fulfil the requirements.
- However, porosity and chromium-rich precipitations observed in thicker parts
- Inferior mechanical properties of such defected areas revealed compared to un-effected areas

### Next planned activities:

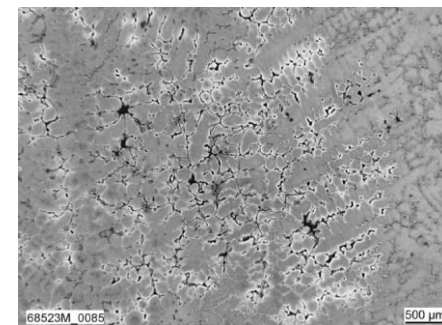
- Investigation of appearance of the local precipitations and of the increased local porosity
- Testing the LCF- and TMF-behaviour of specimens taken from as-cast prototype casing
- Component tests on a turbocharger test rig will be carried out



*As-cast prototype*



*Cross-section through a prototype casing and FPI pattern*



*Local precipitations and porosity*