INSTITUTO DE PESQUISAS TECNOLÓGICAS

COMUNICAÇÃO TÉCNICA

N° 180143

Hydrophobic coatings for corrosion protection in offshore environments

Zehbour Panossian
Danae Lopes Francisco
Daiana Guerra Sacilotto
Shirley Vanessa Navas Diaz
Millena Fernandes Brito Caires
Oscar Maurício Prada Ramirez
Idalina Vieira Aoki
Hercílio Gomes de Melo

Palestra apresentado no AMPP ANNUAL CONFERENCE AND EXHIBITION, 2026, Houston. 20 slide.

Instituto de Pesquisas Tecnológicas do Estado de São Paulo S/A - IPT
Av. Prof. Almeida Prado, 532 | Cidade Universitária ou
Caixa Postal 0141 | CEP 01064-970
São Paulo | SP | Brasil | CEP 05508-901
Tel 11 3767 4374/4000 | Fax 11 3767-4099

www.ipt.br

Hydrophobic Coatings for Corrosion Protection in Offshore Environments

IPT

Zehbour Panossian (Zepir)

Danae Lopes Francisco

Daiana Guerra Sacilotto

Shirley Vanessa Navas Diaz

Millena Fernandes Brito Caires

Oscar Maurício Prada Ramirez

USP

Idalina Vieira Aoki

Hercílio Gomes de Melo

Introduction

Mission

Developing fundamental scientific research and cutting-edge technologies for the Offshore of Tomorrow through a multidisciplinary and innovative venture that combines academia, industry and government

OTIC

OFFSHORE TECHNOLOGY INNOVATION CENTRE

Creating the Offshore of Tomorrow

ipt USP FAPESP

Sponsors

Introduction

5 Programs

SCOPE IN APPLICATIONS IN TOPSIDE AND SUBSEA SYSTEMS

NEW PROCESSES AND OPERATIONS

LOW CARBON ENERGY

FOCUS ON TECHNOLOGY

DIGITAL TRANSFORMATION

NEW MATERIALS & NANOTECHNOLOGY

HEALTH, SAFETY, ENVIRONMENT AND CIRCULAR ECONOMY

CHALLENGE IMPOSED BY THE FUNDING AGENCY

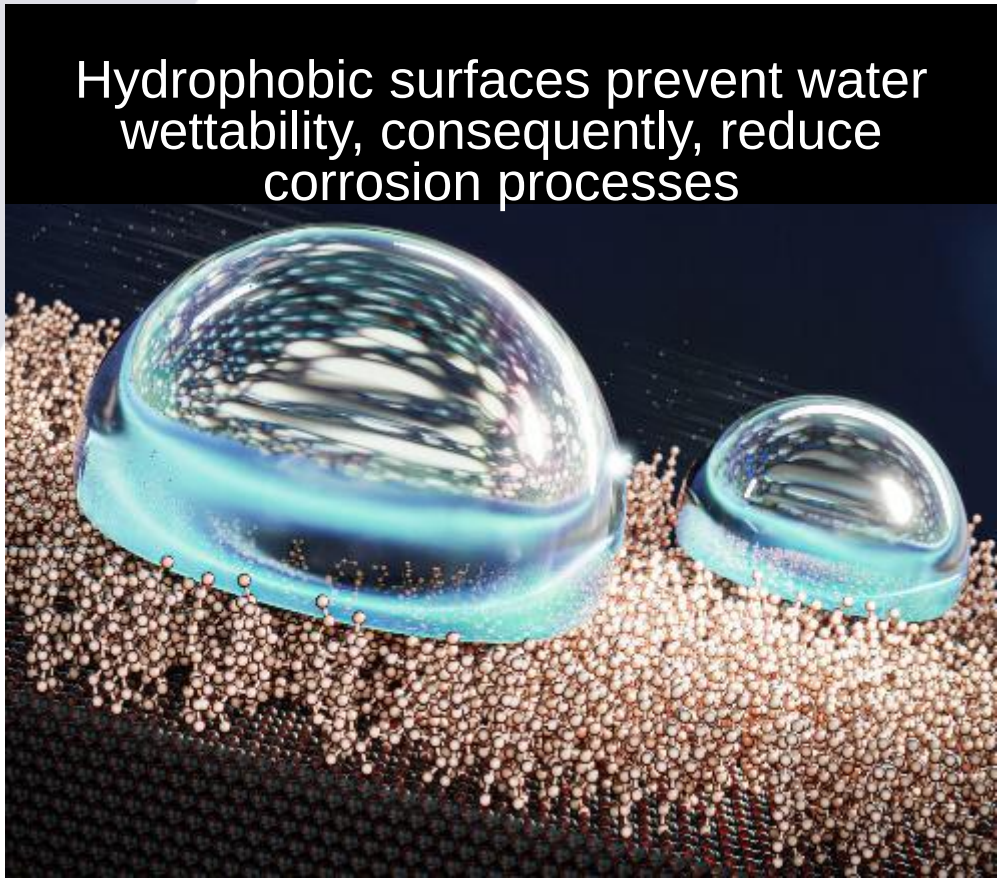
Extending the useful life of steel structures in offshore environments through DISRUPTIVE INNOVATION

Specifically, developing a hydrophobic coating with long term durability

Reduction of operation/maintenance costs (OPEX)

Reduction of potential health, safety and environmental (HSE) harms

Introduction

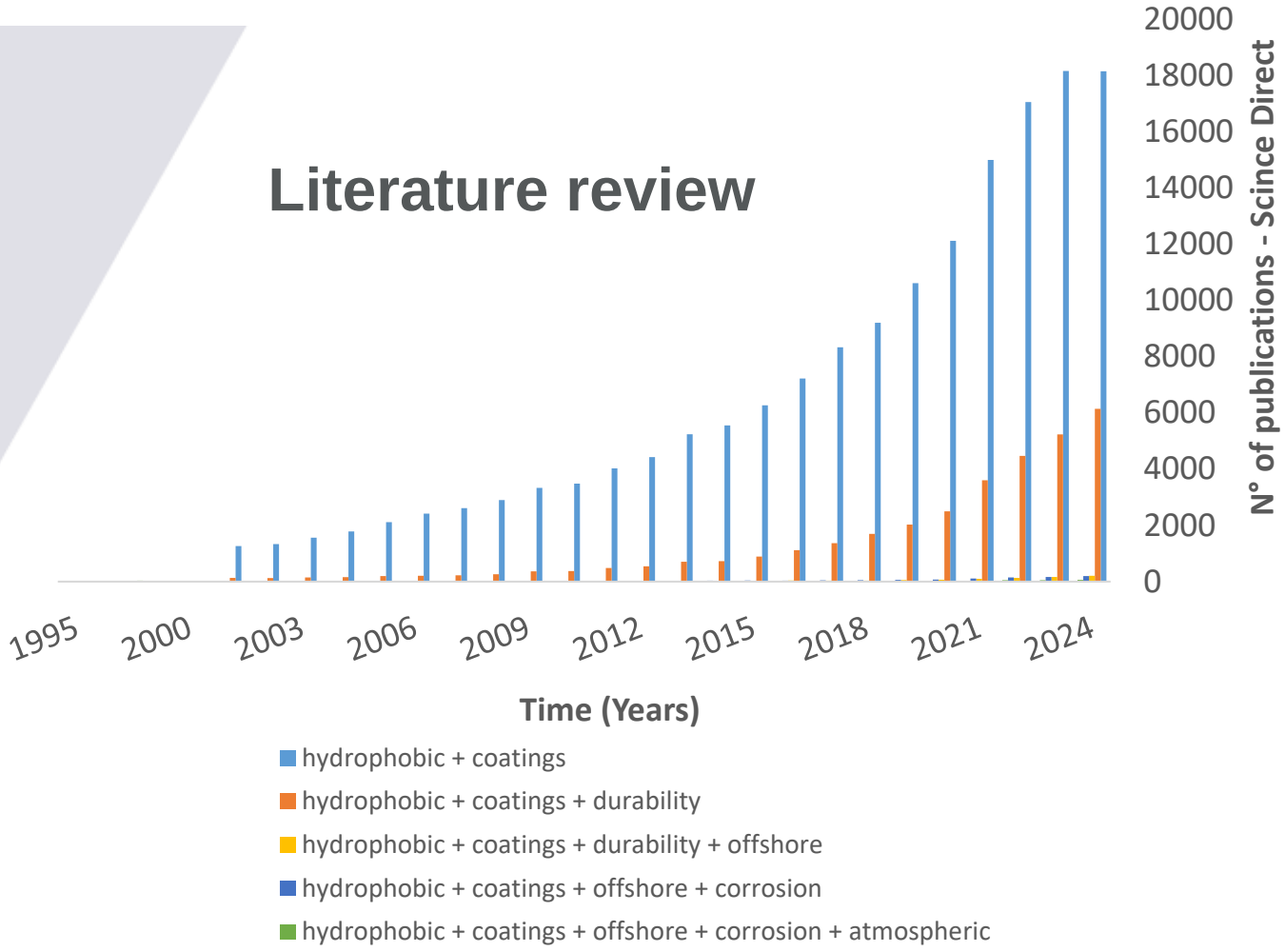


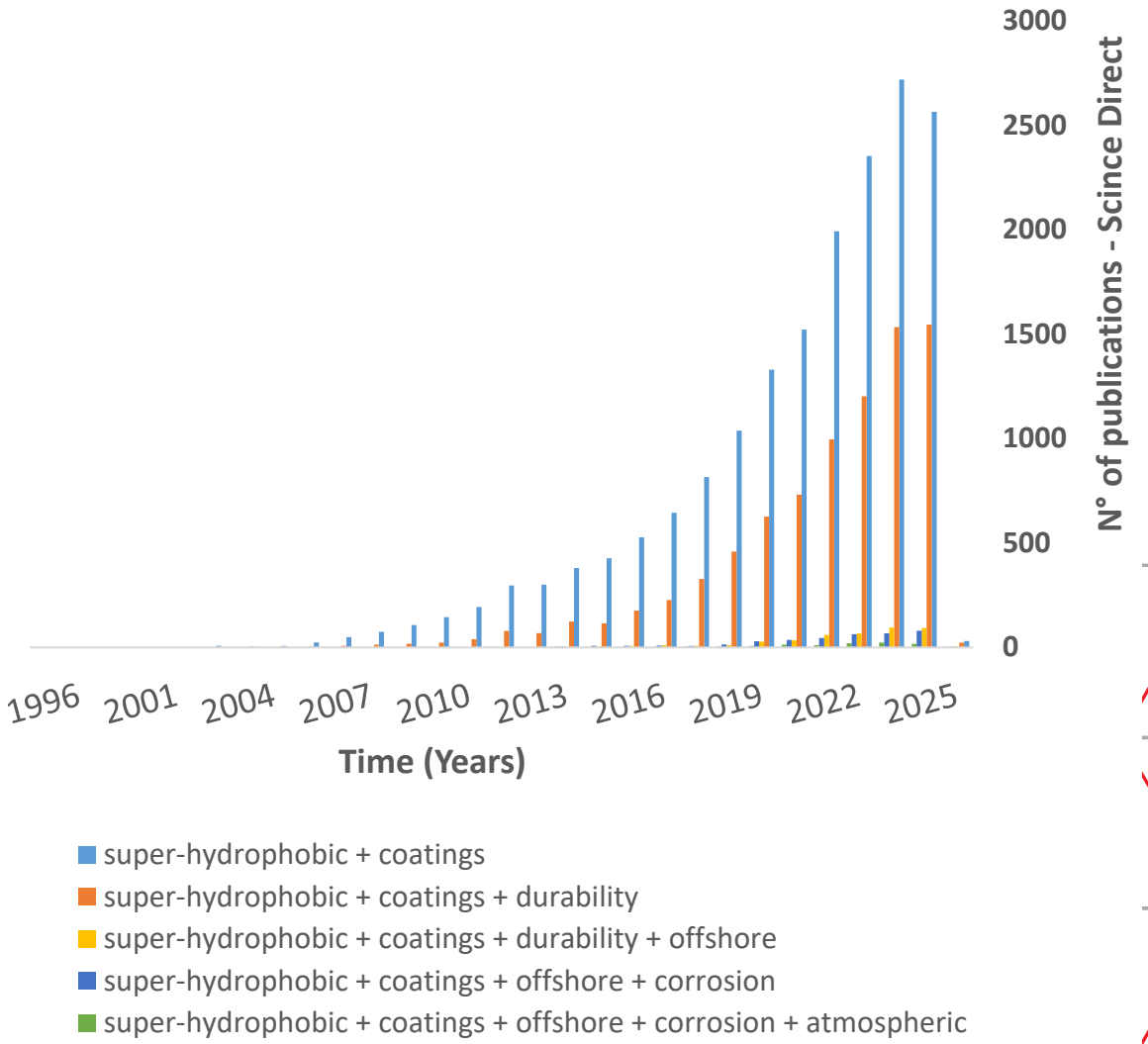
Hydrophobic surface are currently obtained by developing a micro-nano structure on a metallic surface.

Efficient hydrophobic surfaces are commonly produced in the market.

Durability is the main hurdle for practical applications, as mechanical wear, UV radiation, and chemical exposure can destroy the delicate micro-nano structures necessary for water repellency.

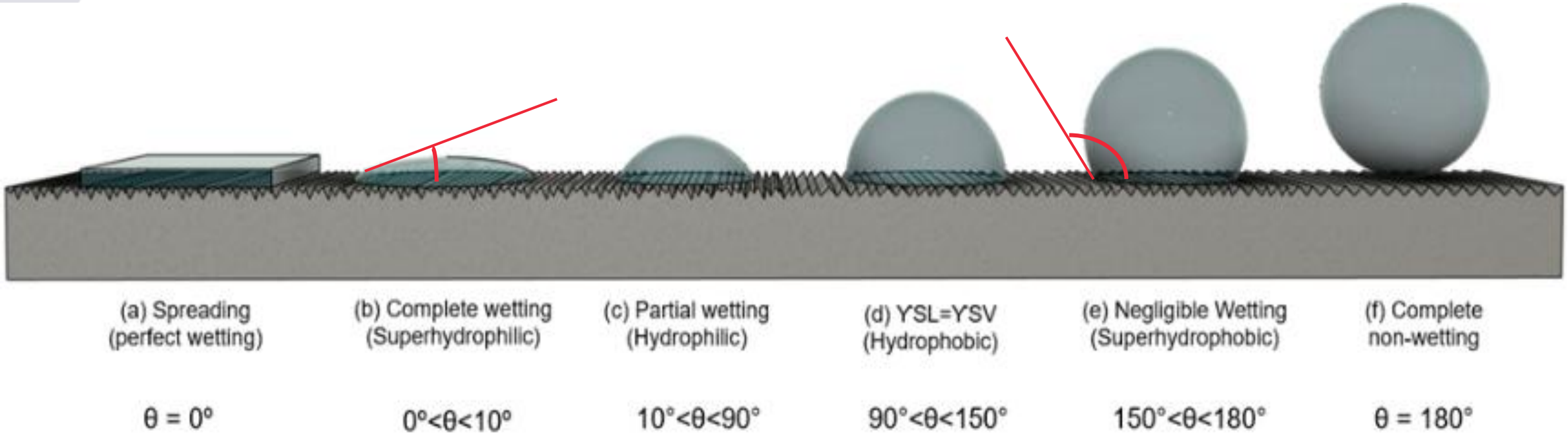
Introduction





Introduction

Hydrophobicity can be characterized by **water contact angle**.



Hydrophobic surface: water contact angle > 90°.
Super-hydrophobic surface: water contact angle > 150°

Objective

To develop a hydrophobic paint with high durability.

Secondary objective: rapid commercialization of the developed paint!

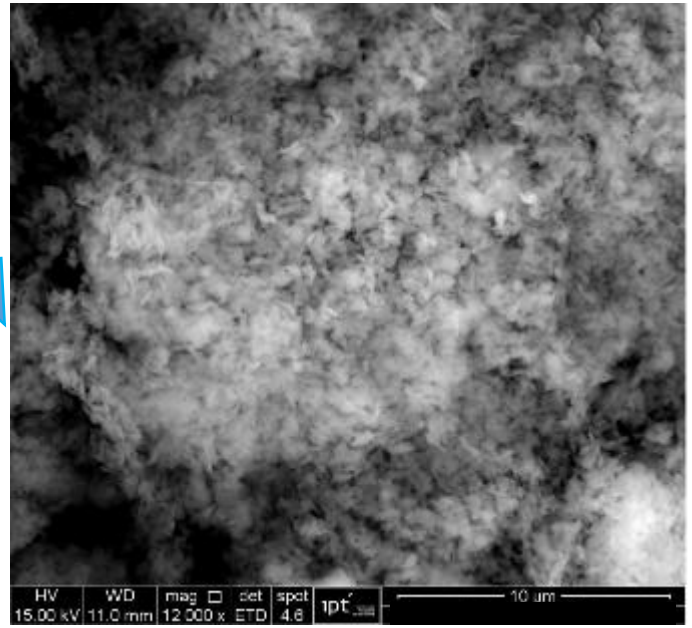
Xiao *et al.* (2023)

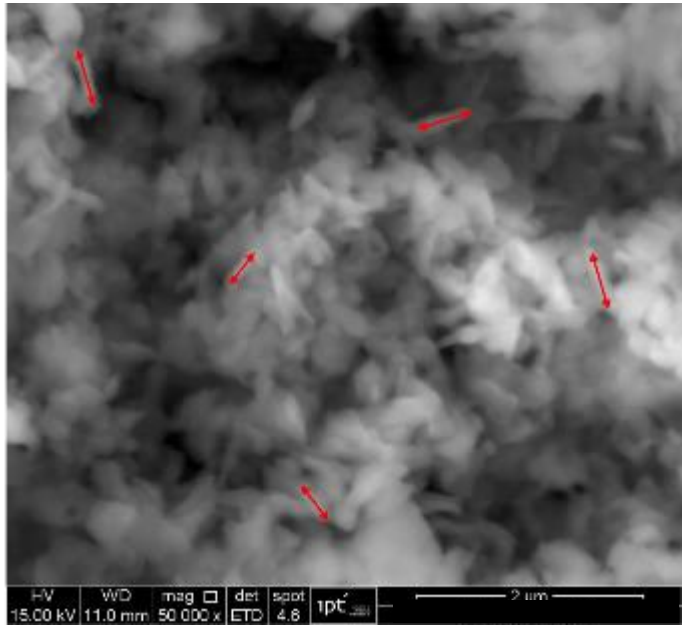
Methodology

- Establishment partnership with **three** paint manufacturer: after signing an agreement, the manufacturers disclosed the paint composition.
- Four organic based topcoats were selected: polyaspartic, epoxy, flexible epoxy, and **acrylic**.
- The manufacturer provided all the paint components for the paint preparation in our laboratory.
- Broad literature review and full discussion were performed to identify paint modifiers, which can give hydrophobic properties to the selected paint. Three modifiers were selected.
- Modifications of the paint composition were performed.
- Two **go/no go** screening tests were selected to perform rapid selection of the most promising paint composition: contact angle and Taber abrasion tests.

Methodology

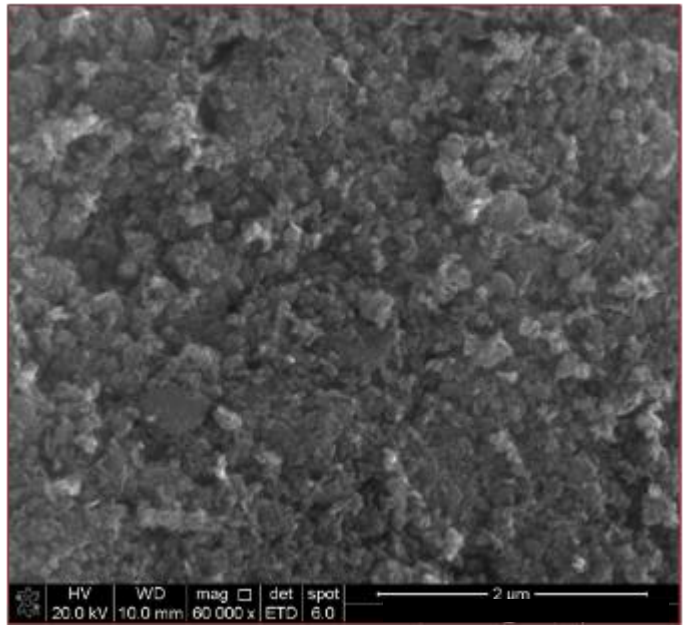
CeO_2





Modifiers incorporation:

- ✓ Nanometric CeO_2 (0.1 % and 0.5 %) mass;
- ✓ Graphene:
  - **G1 - nanoplatelets** (0.01 % and 0.1 % in powder (**G.1P**) and dispersed (**G.1D**) with high specific surface area.
  - **G2 - nanoplatelets** (0.01 % and 0.1 %, mass) – dispersed **G.2D**
- ✓ Stearic acid (0.5 % and 1 %, mass)



Graphene

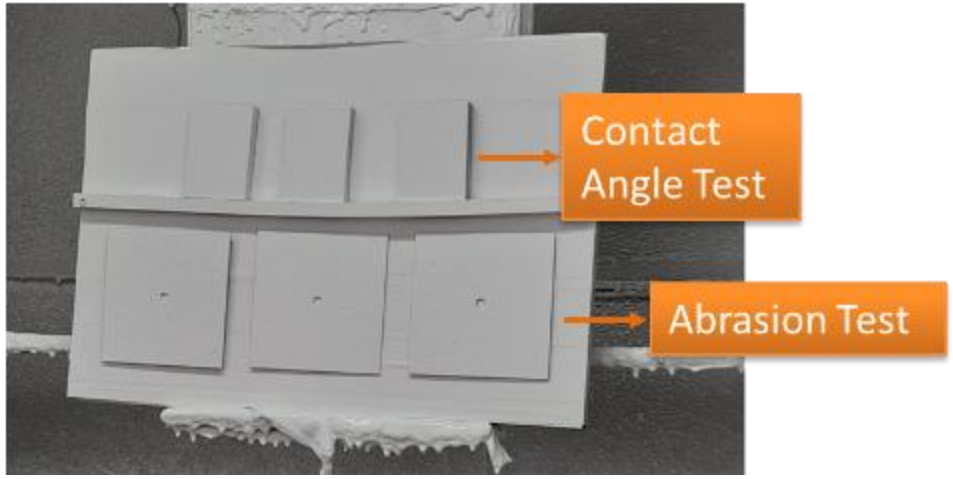
Stearic acid

Methodology

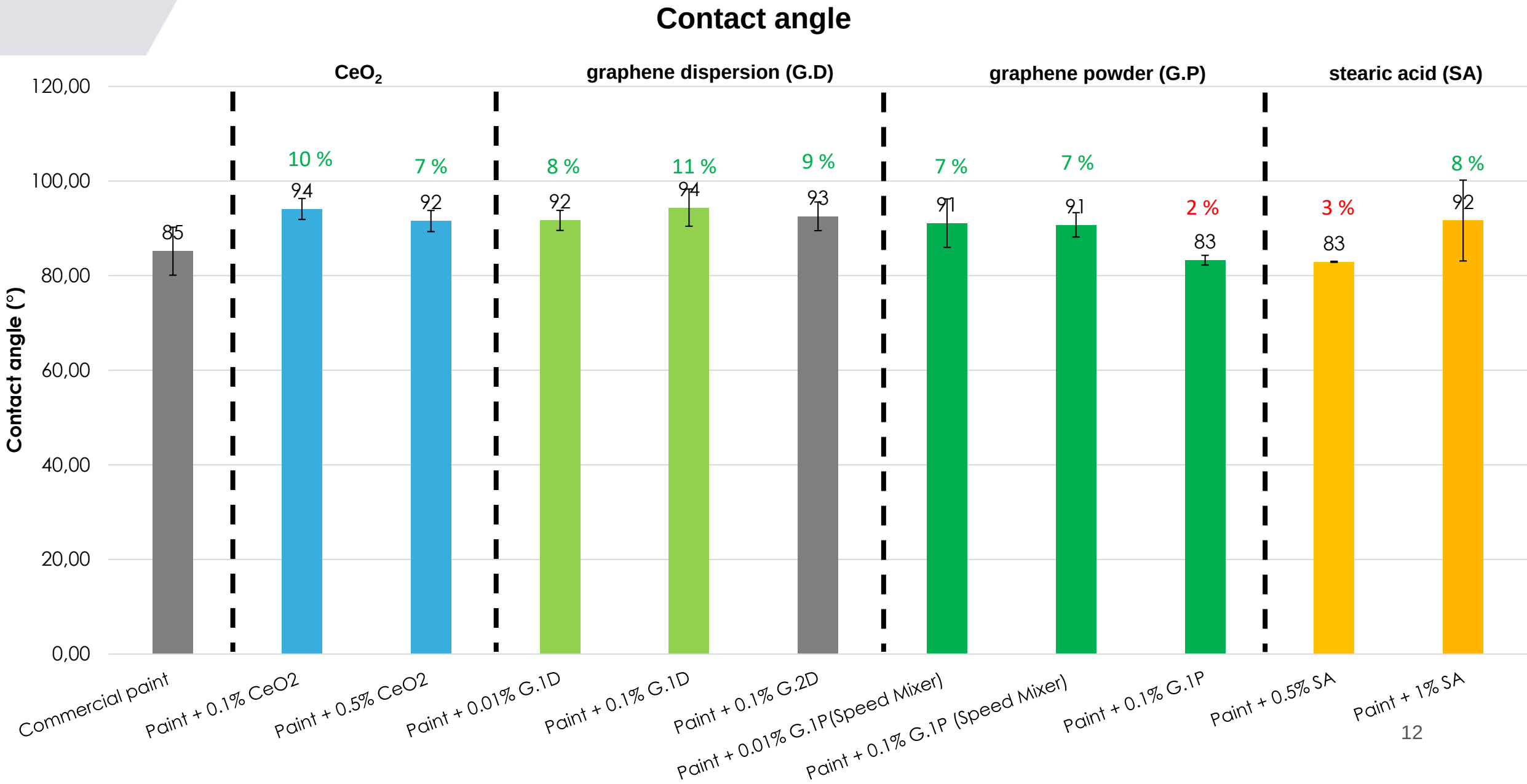
- Paint production, application and screening tests.

Commercial paint preparation in our Laboratory

After modification of the paint composition



Partial results

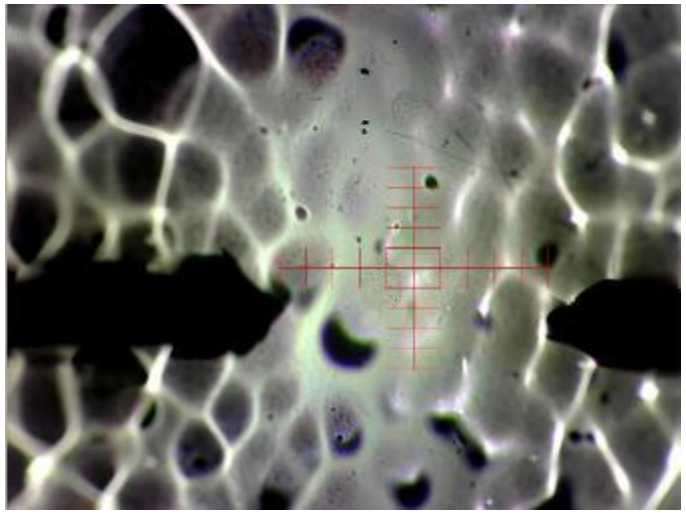


Partial results

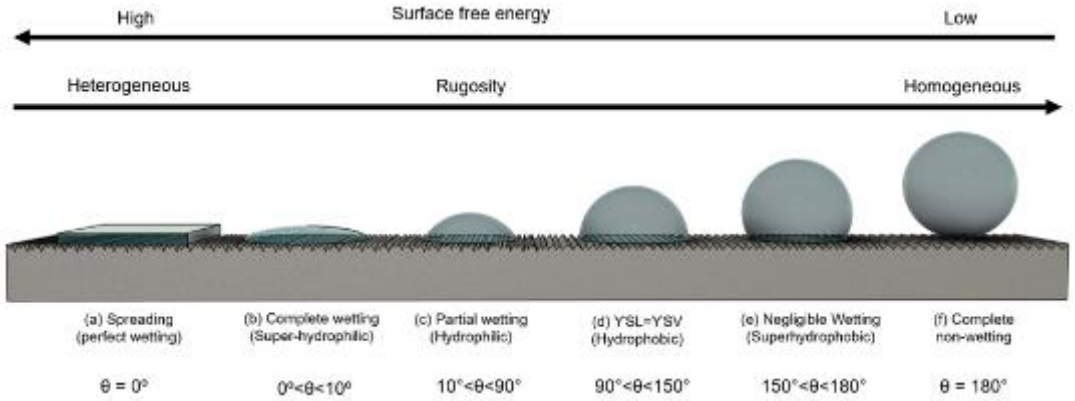
Water contact angle (WCA) T0

Abrasion test

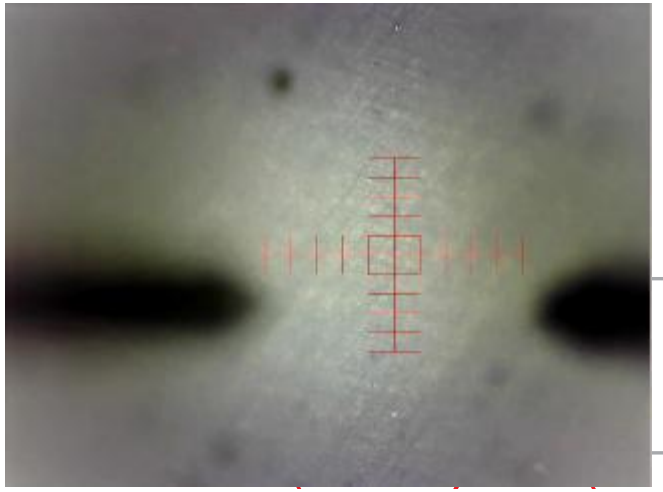
Water contact angle (WCA) T1



As painted



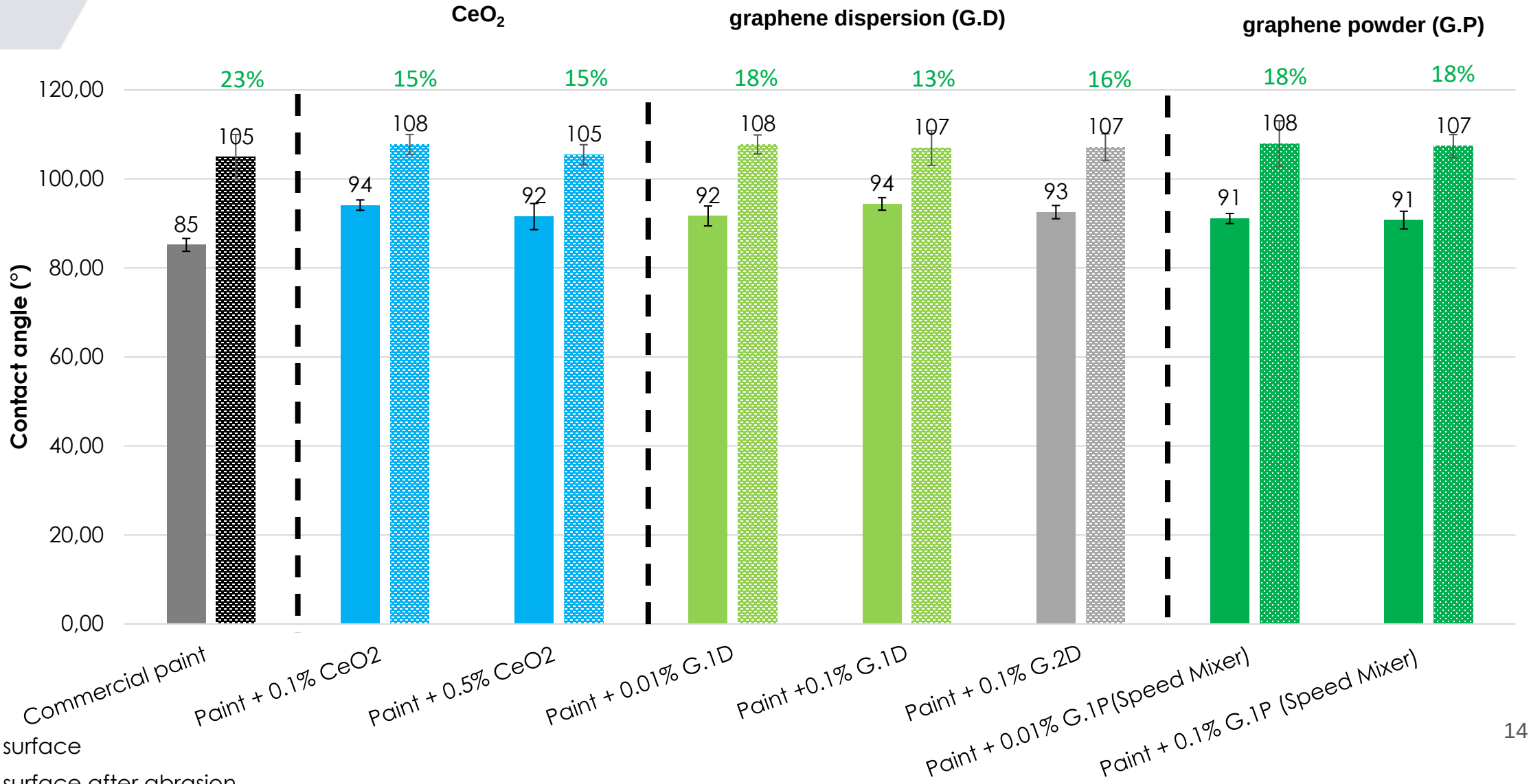
Surface image of the painted steel obtained by a profilometer



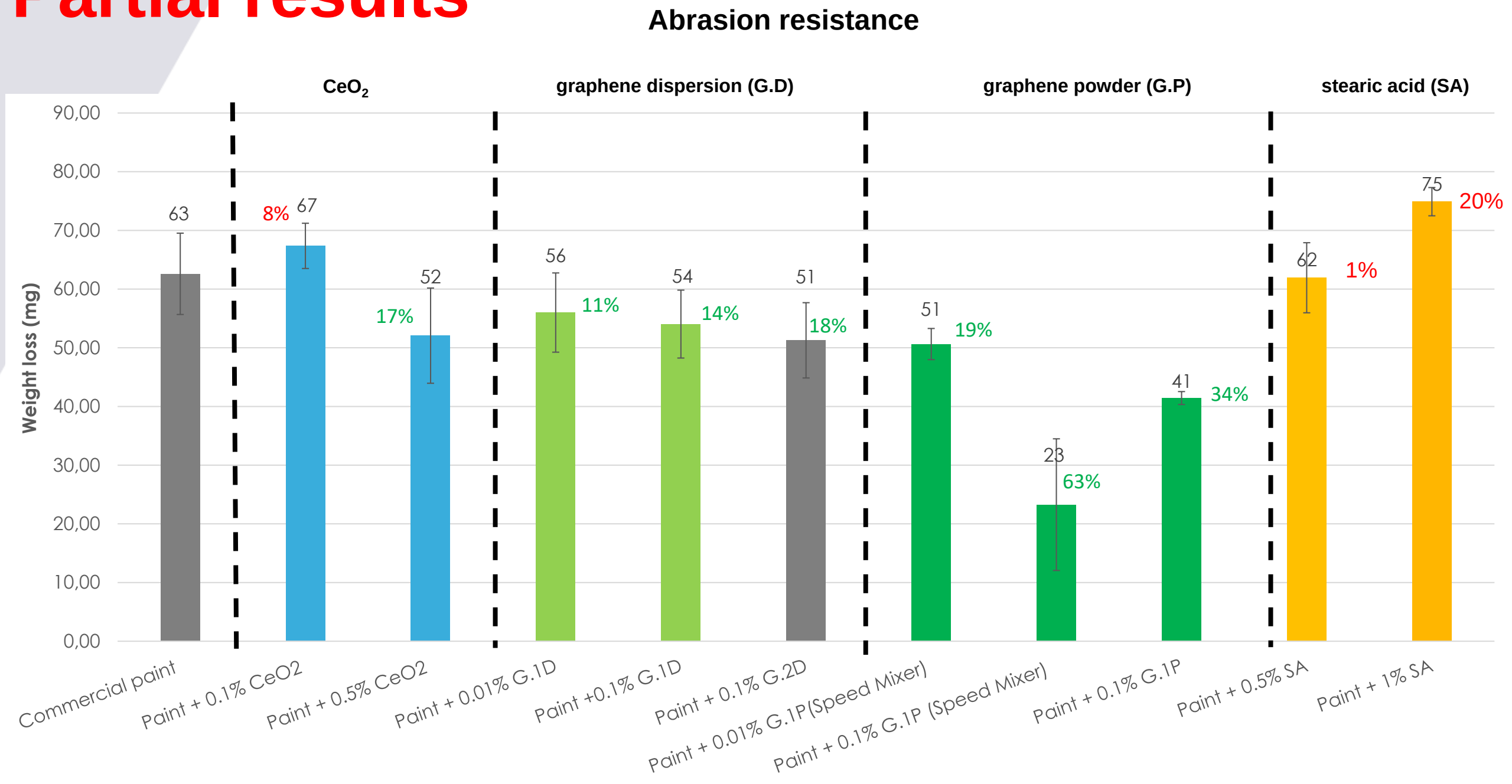
After Taber abrasion test

Partial results

Contact angle: before and after abrasion test



Partial results



Partial conclusions

Modified particles	Abrasion resistance increase (%)	CA increase (%)
Commercial paint	-	
Paint + 0.5 % CeO_2	17	10
Paint + 0.01 % G1.D	11	8
Paint + 0.1 % G1.D	14	11
Paint + 0.01% G1.P (speed mixer)	19	7
Paint + 0.1% G1.P (speed mixer)	63	7
Paint + 0.1 % G1.P	34	-2
Paint + 0.1% G2.D	18	9

Aiming to increase more the hydrophobicity

AE (stearic acid)
SE (cerium stearate)
TS (titanium stearate)
Functionalize the original paint particles

Partial conclusions

- Graphene nanoplates does not improve significantly the hydrophobicity of studied paint (acrylic).
- The paint containing 0.1 % graphene, prepared at a high mixing speed, improved the abrasion resistance of the commercial paint by 63 %.
- The increased homogeneity of the surface roughness after the abrasion test led to a higher contact angle for all samples studied.
- The incorporation of pure stearic acid reduces the abrasion resistance and does not significantly increase the hydrophobicity.

Next step

- Improvement of the modifiers' dispersion.
- Modification of the paint formulation through stearic acid derivatives (i.e. cerium stearate, titanium stearate).

Acknowledgement

The authors gratefully acknowledge AMPP, the OTIC (Offshore Technology Innovation Centre), FAPESP São Paulo Research Foundation (2022/03698-8), and Shell Brasil; and the support given by ANP (Brazil's National Oil, Natural Gas and Biofuels Agency) through the R&D levy regulation.

Thank you!

Zehabour Panossian and the OTIC-IPT Team
zep@ipt.br