

Chemical characterization on laser marked white polymer materials

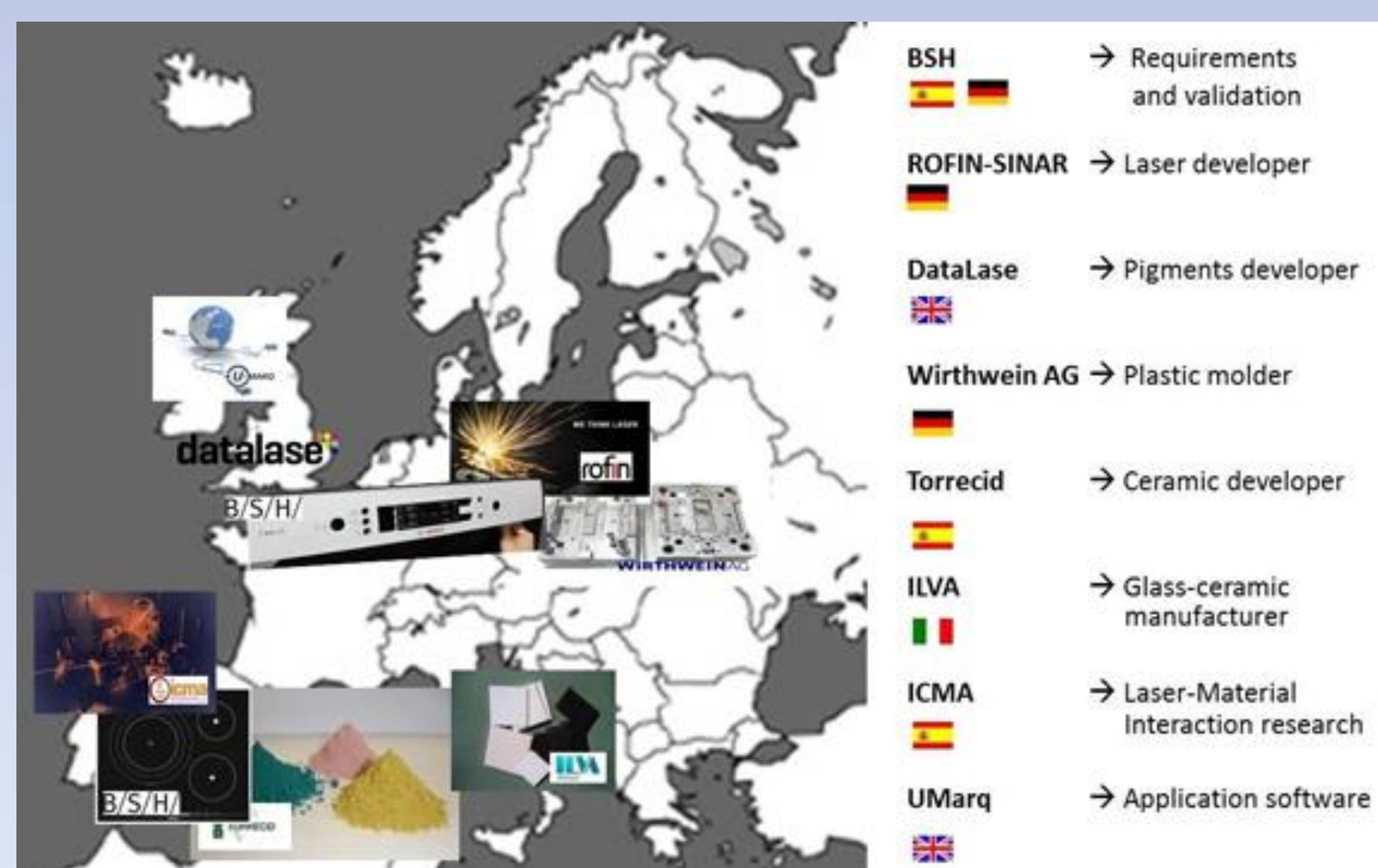
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Development of a new laser for customization at industrial level through high quality marking of different materials

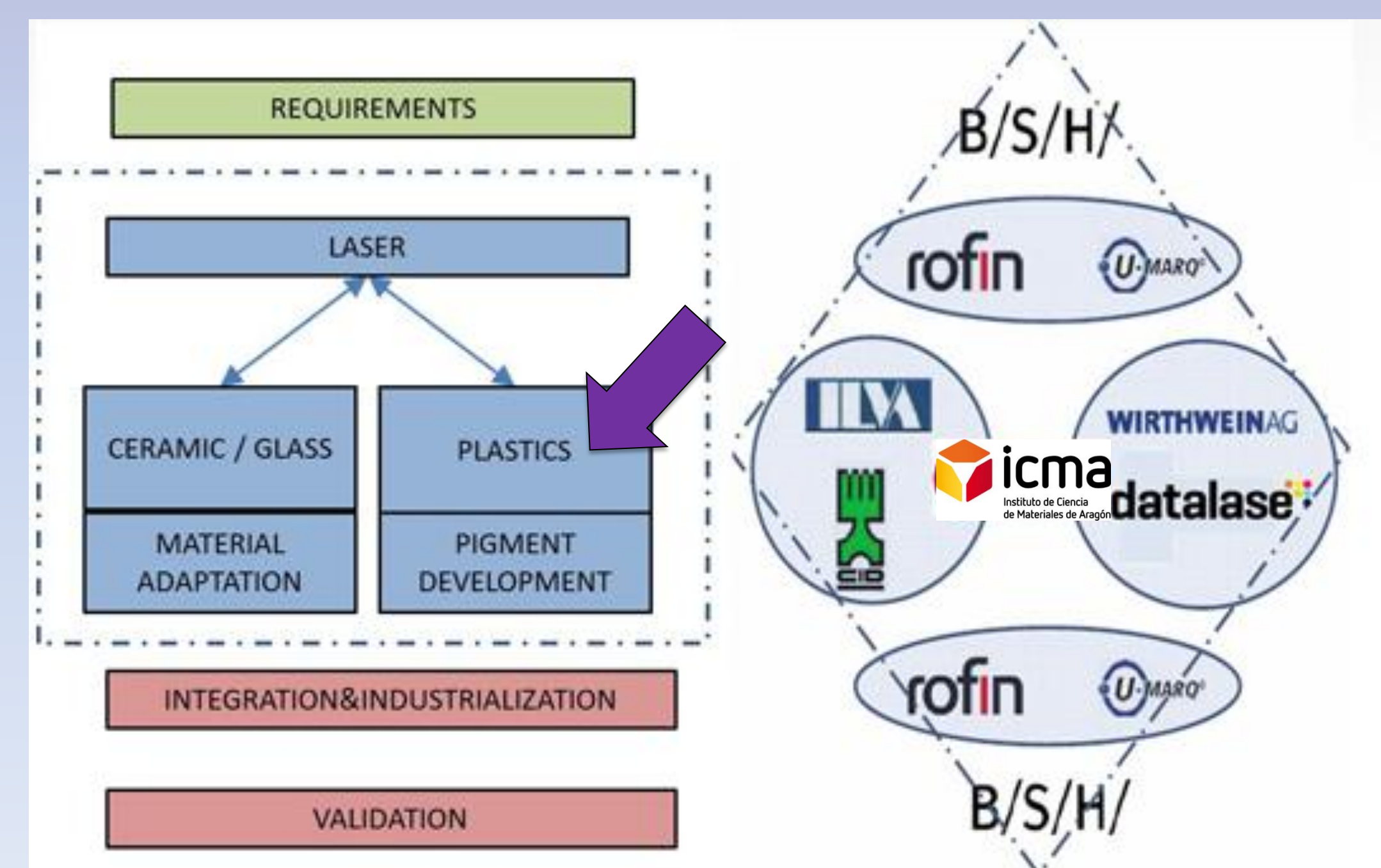
CONSORTIUM



MAIN OBJECTIVES

- ✓ Developing a new laser in the UV range
- ✓ Adapting existing materials for having a better beam absorption
- ✓ Integrating the laser in the industrial process
- ✓ Developing a user application for demonstrating the unitary customization with real customers.

WORK PROJECT DESCRIPTION



MATERIAL

White pigmented polymeric materials, widely used in home appliances

UV-MARKING ITEMS

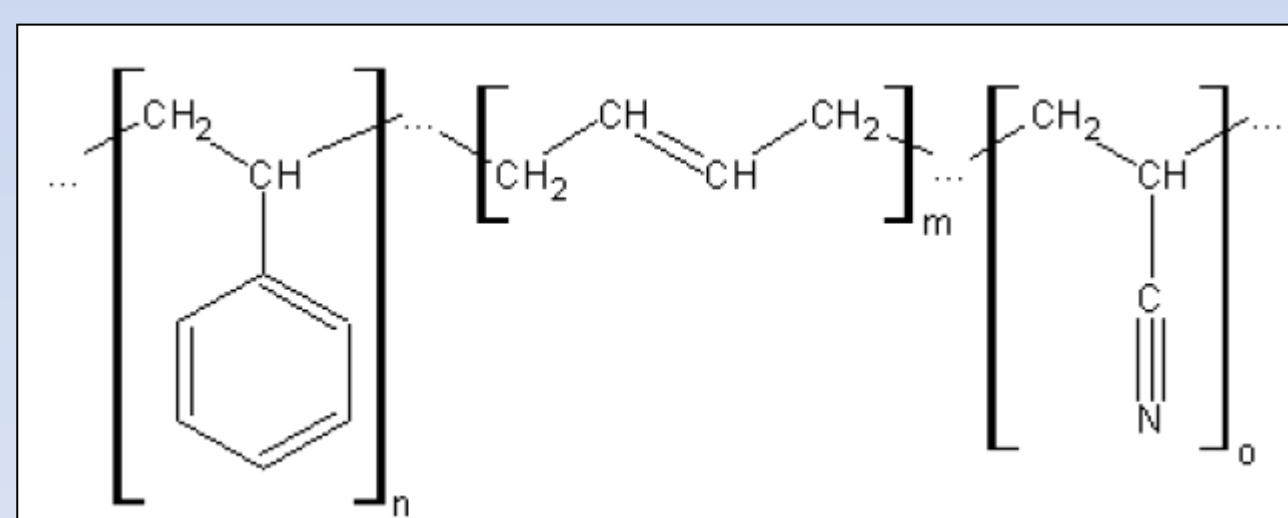


- ✓ Dishwashers
- ✓ Washing machines
- ✓ Fridges
- ✓ Irons

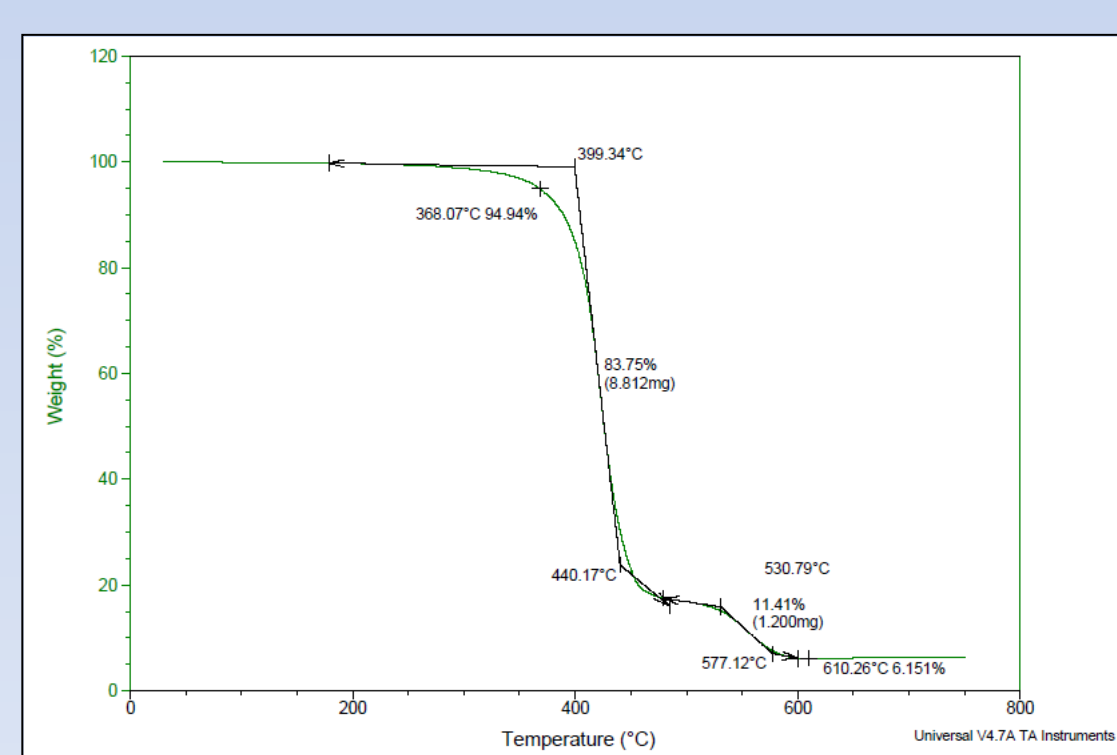
ABS

Acrylonitrile-Butadiene-Styrene

+ TiO₂ based white pigment

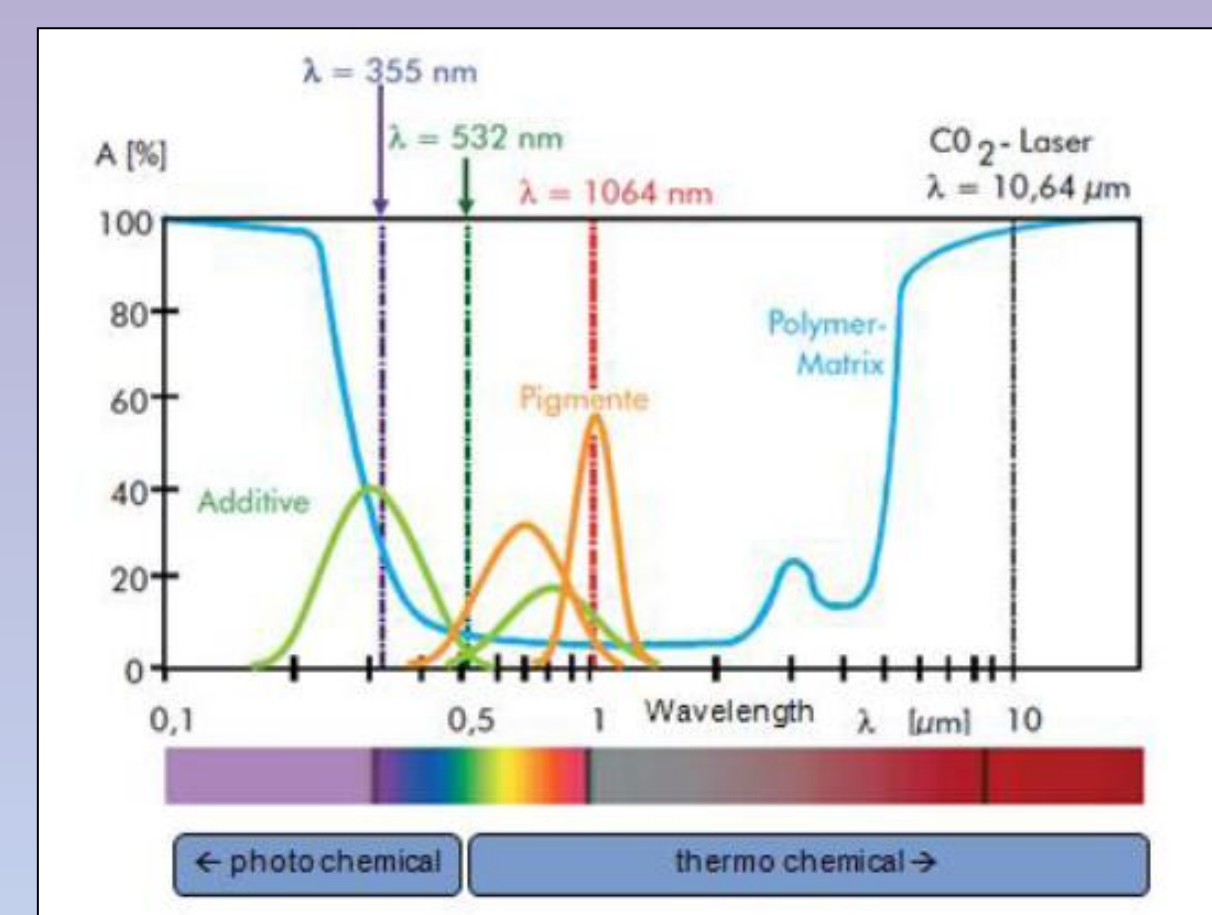


Chemical structure of ABS



Thermogravimetric assay to determine the inorganic residue in a white ABS polymer

Marking in the UV range (355 nm)

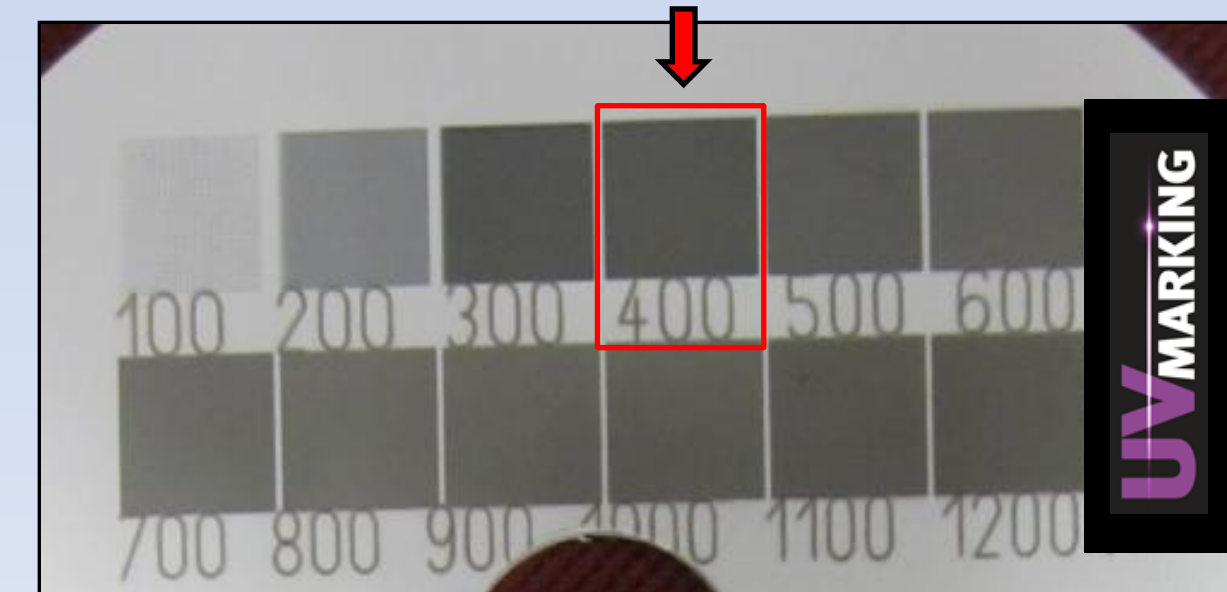


LASER TECHNOLOGY

UV-laser produces photo-chemical reaction and minimal thermal damage of the material

White → UV-Marking → Grey

Selected as the best color mark



Different marks made by UV-laser increasing DPI (dot per inch) parameter



Marks depend on

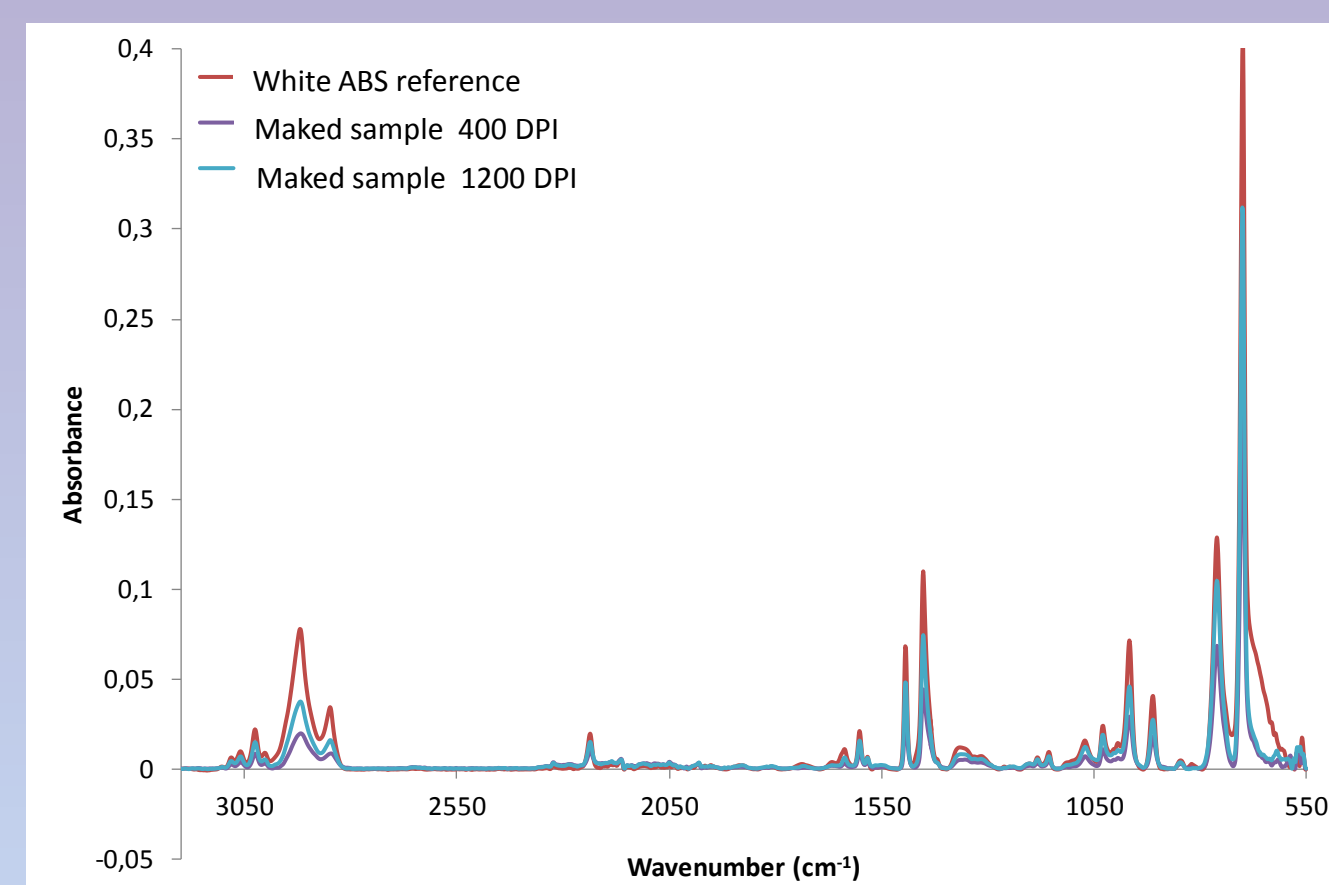
Laser parameters Polymer structure or additives

- ✓ Pulse Frequency
- ✓ Pulse Time
- ✓ Pulse Energy
- ✓ Spot diameter
- ✓ DPI (dot per inch)

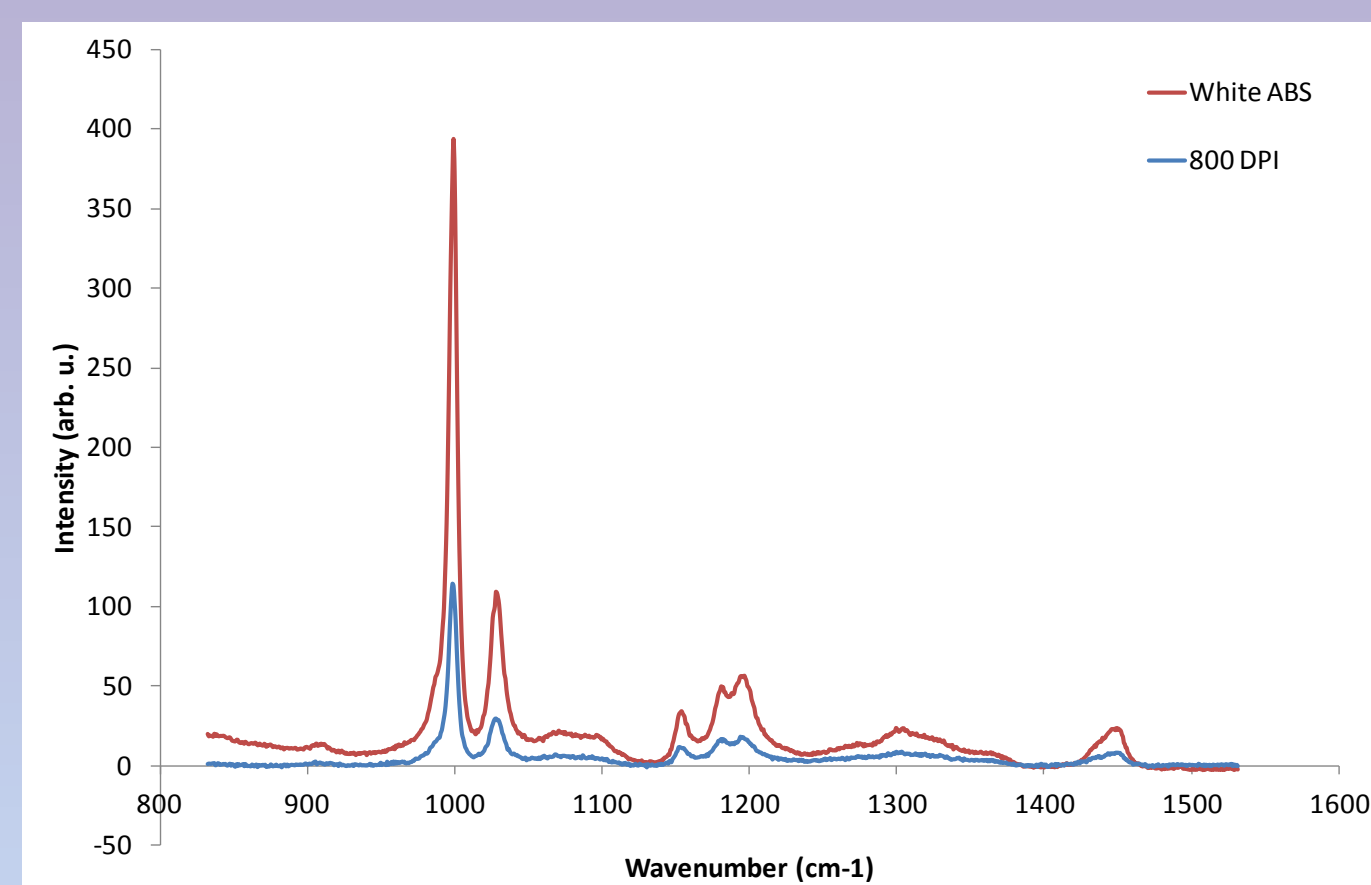
Results shown here were made on marked samples changing dpi parameter

How selected plastic material is affected by UV-laser marking?

ORIGINAL AND MARKED ABS STRUCTURAL COMPARISON



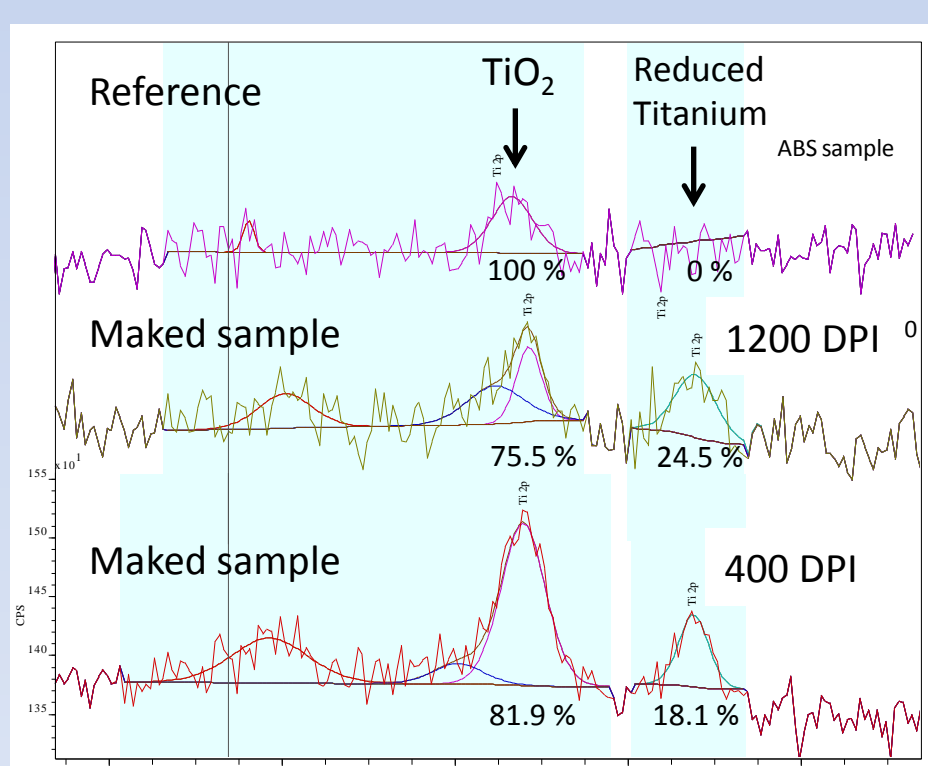
ATR-FTIR spectra of ABS and marked samples increasing DPI parameter (550-4000 cm⁻¹)



Raman spectra of ABS and marked samples increasing DPI parameter (900-1500 cm⁻¹, λ = 496.5nm)

✓IR and Raman spectra of marked samples correspond to ABS without significant evidences of degradation

✓Two electronic states were found for titanium element. Reduced Ti is related to laser marking effect.



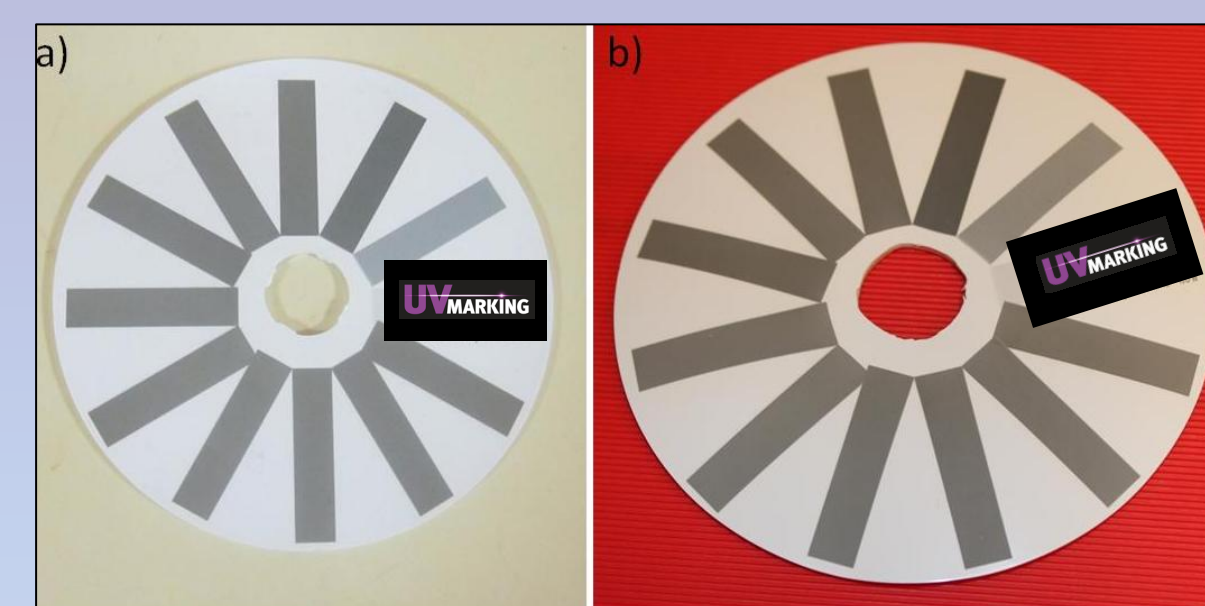
High resolution X-ray photoelectron spectroscopy spectra of titanium in ABS and marked samples increasing DPI parameter

TESTS TO QUANTIFY MARK QUALITY

Validation tests to satisfy company's requirements

CLIMATE TEST

Resistance to environmental conditions (accelerated exposition to temperature, moisture and light)



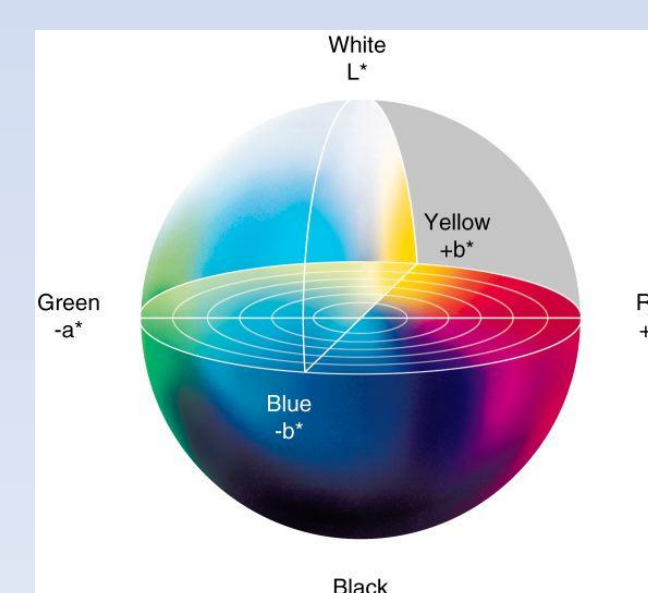
Tested white ABS disc before (a) and after (b) climate test.



Marked samples immersed in different chemical agents

Resistance to chemical agents: bleach, olive oil, vinegar, sodium hydroxide, hydrochloric acid ...

CHEMICAL RESISTANCE TEST



Color coordinates system CIELAB
L* (lightness) black and white scale

Color Measurements before and after testing

✓ Good resistance under accelerated climate conditions and chemical agents

CONCLUSION

Chemical structure of the polymer seems to be resistant to UV-laser marking. Titanium dioxide has a strong influence on the marking process. Laser marks have good chemical and climate resistance and pass the validation test.

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