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PHYSICAL AGING OF EMULSIONS CONTAINING COATED TiO₂ NANOPARTICLES: INTERACTION BETWEEN NANOPARTICLES AND OTHER INGREDIENTS

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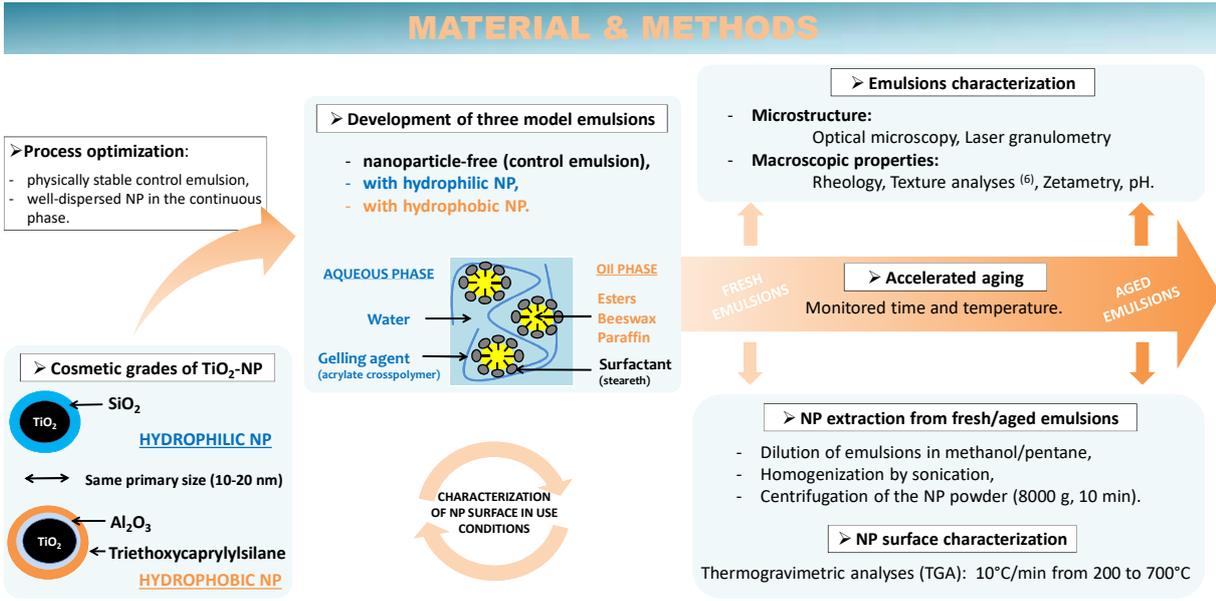
INTRODUCTION

Titanium dioxide (TiO₂) nanoparticles (NP) are commonly used in cosmetics as UV filters ^{(1) (2)}.

For cosmetic grades, coatings are applied to prevent TiO₂ radical oxidation / contact with ingredients ^{(3) (4)}. These coatings procure to the NP their surface properties (polarity, charge) and impose their behavior in emulsion.

During formulation and storage, cosmetic emulsions are exposed to aggressions which can induce and/or aging. NP in emulsion may aggregate, adsorb formula's compounds or be deteriorated ⁽⁵⁾.

The surface modifications of the NP are here studied as they could explain the (de)stabilisation mechanisms in emulsion.



RESULTS & DISCUSSION

FRESH EMULSIONS CHARACTERIZATION

- **Similar microstructures:**
 - Homogeneous
 - Fine droplets.
- **But slight differences:**
 - Less flocculated with hydrophilic NP emulsion,
 - Large aggregates with hydrophobic NP.

AGED EMULSIONS CHARACTERIZATION

- **Emulsions not demixed.**
- **Different microstructures:**
 - Control emulsion: few larger droplets,
 - Hydrophilic NP: enhanced stability,
 - Hydrophobic NP: larger aggregates (50 µm).

Macroscopic properties:

- Not affected by the presence and nature of NP and confirmed by other methods (pH, rheology...).

Control remains unchanged,

- Emulsion with hydrophilic NP: more consistent (NP/droplets network)
- Emulsion hydrophobic NP: fall of consistency (demixion)

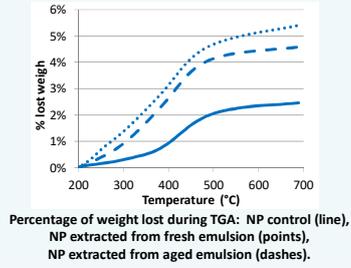
Table: Probe work (kg.s)

Emulsion Type	Probe work (kg.s)
Fresh emulsions Control	0.17 ± 0.02
With hydrophilic NP	0.19 ± 0.03
With hydrophobic NP	0.19 ± 0.03
Aged emulsions Control	0.24 ± 0.05
With hydrophilic NP	0.32 ± 0.00
With hydrophobic NP	0.08 ± 0.02

Compression test: (Micrographs showing droplet aggregation)

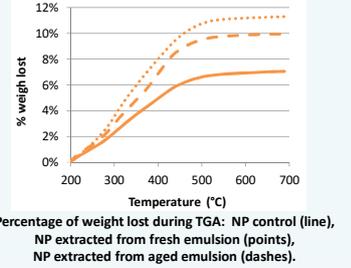
Volumetric repartitions of colloids in fresh/aged emulsions: (Particle size distribution graphs showing shifts in peaks)

EXTRACTED HYDROPHILIC NP FROM FRESH/AGED EMULSIONS



- **Thermogravimetric analyses on NP:**
 - When extracted from fresh/aged emulsions, higher weight lost than the control.
 - No difference between NP extracted from fresh/aged emulsions.
- **In both cases, evidencing of adsorption of emulsion compounds on the NP surface.**

EXTRACTED HYDROPHOBIC NP FROM FRESH/AGED EMULSIONS



CONCLUSION

In this work, two natures of coated TiO₂ NP were studied in cosmetic emulsions. This leads to innovative characterizations of particles in complex media. Whereas hydrophilic NP stabilize emulsion by steric hindrance, during aging, hydrophobic NP form large aggregates that make the emulsion less homogenous and alters the emulsion macroscopic properties (spreading quality,...).

Innovative protocols for NP extraction from the fresh/aged emulsions were developed. Characterizations by TGA proved that emulsion compounds quickly adsorbed the NP surface which modified the NP chemistry and properties. Hence, the observed mechanisms in emulsions are linked to the surface nature of the NP and moreover, these surface modifications have to be taken into account.

PERSPECTIVES

In order to clarify the role of NP surface modifications on the mechanisms in emulsion, the chemistry of the adsorbed molecules have to be explored by further methods for chemical analysis. Moreover, studying the impact of adsorbed species on the surface properties (polarity, charge) will allow understanding these complex phenomena.

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