Synthesis And Evaluation of Performance Test Results of Sustainable Controlled Flocculation Agent for Titanium Dioxide (TiO_2) Containing Systems

Ali Ata ALKAN
Denge Kimya / Izmir Institute of Technology

#PaintİstanbulCongress

5 DECEMBER 2023

CONTENT

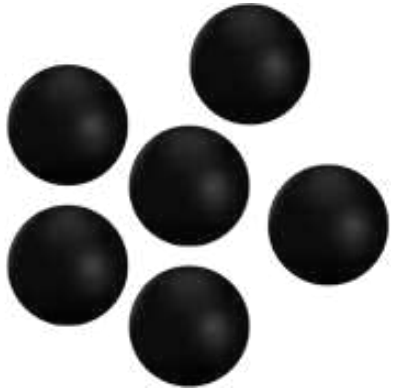
- **INTRODUCTION**
  - Dispersing Agents
  - Controlled Flocculation
  - Sustainability
- **DESIGNING SUSTAINABLE CONTROLLED FLOCCULATION AGENT**
  - Motivation
    - Sustainable Sources
    - Importance of TiO2
    - Importance of Controlled Flocculation
  - Desinging
- **PERFORMANCE TEST RESULTS**
  - Fineness of Grinding & Viscosity of Paint
  - Sagging Test
  - Coverage Test
  - Layer By Layer Application
- **CONCLUSION**

What Is **Dispersing Agent?**

A **dispersing agent** is a substance added to a system, often a liquid or a powder, to enhance the dispersion or distribution of particles within that system. Dispersing agents are commonly used to **prevent the clumping or settling of pigment particles.**

Agglomerated Pigments

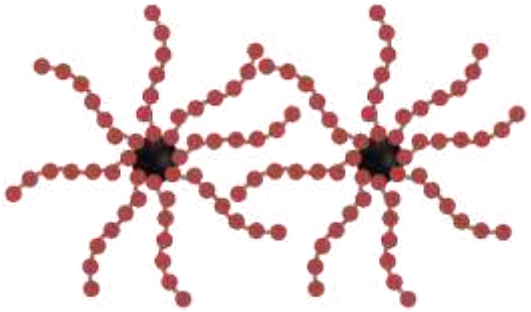
Pigment Aggregates



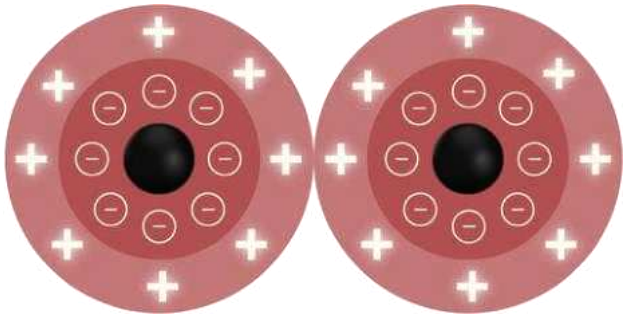
Primary Particles

Effect of **Dispersing Agent**

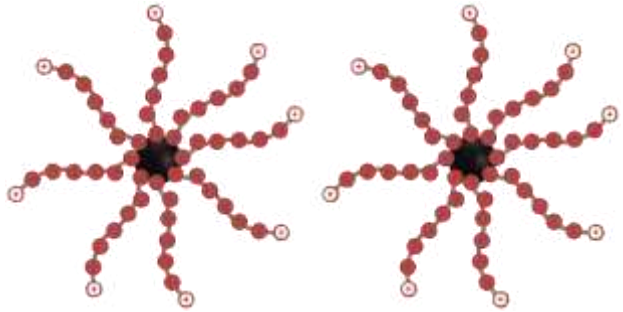
By reducing agglomeration, dispersing agents improve the **stability and consistency of the product**, ensuring **uniform color**, **texture**, and **performance**. These agents typically work by **reducing the surface tension between particles**, promoting their separation and **preventing undesirable interactions.**



Steric Effect



Electrostatic Effect

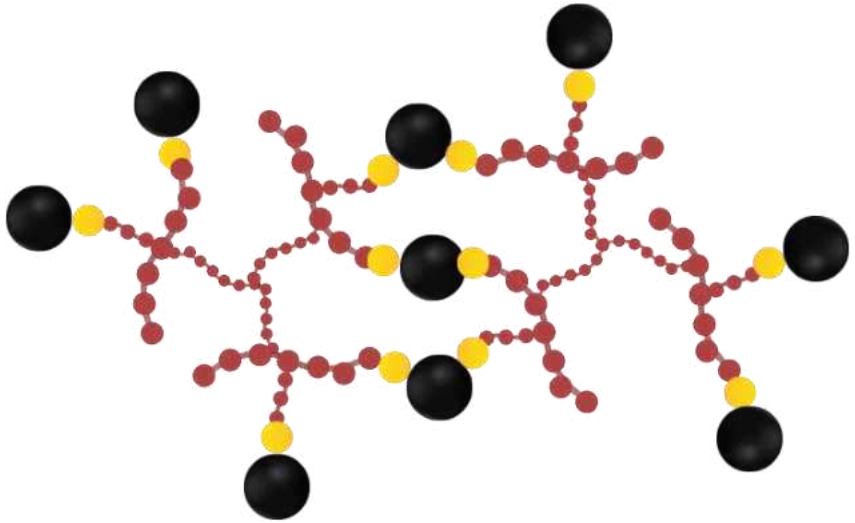


Electrosteric Effect

What Is **Controlled Flocculation?**

A **controlled flocculation agent** in the paint and coating industry is a substance added to formulations to **regulate the flocculation process**, which **involves the aggregation or clumping.**

Strong Difference Between Dispersing Agent and Controlled Flocculation Agent is



Controlled Flocculation Agent

Controlled Flocculation Agents Creates 3D Network in Colloidal System by Interacting with Particles

Why It Is **Needed?**

Unlike standard deflocculation, **controlled flocculation allows for a controlled and reversible aggregation** of particles.

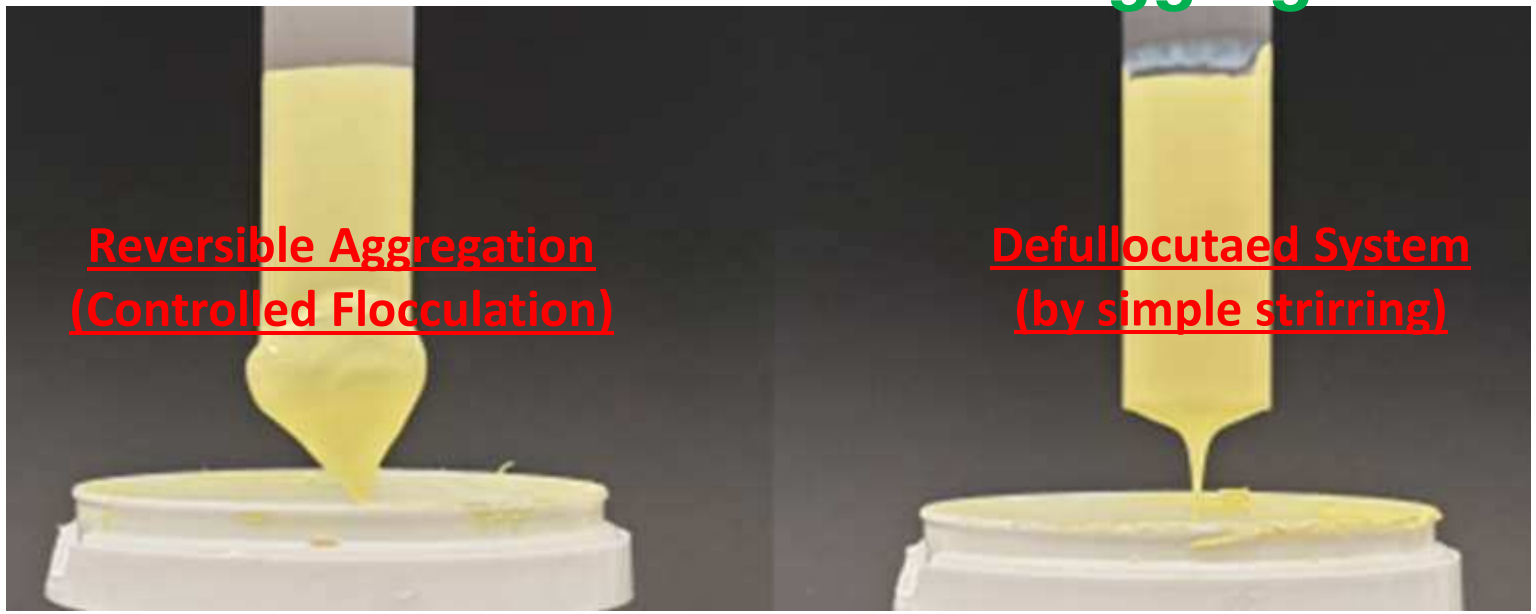
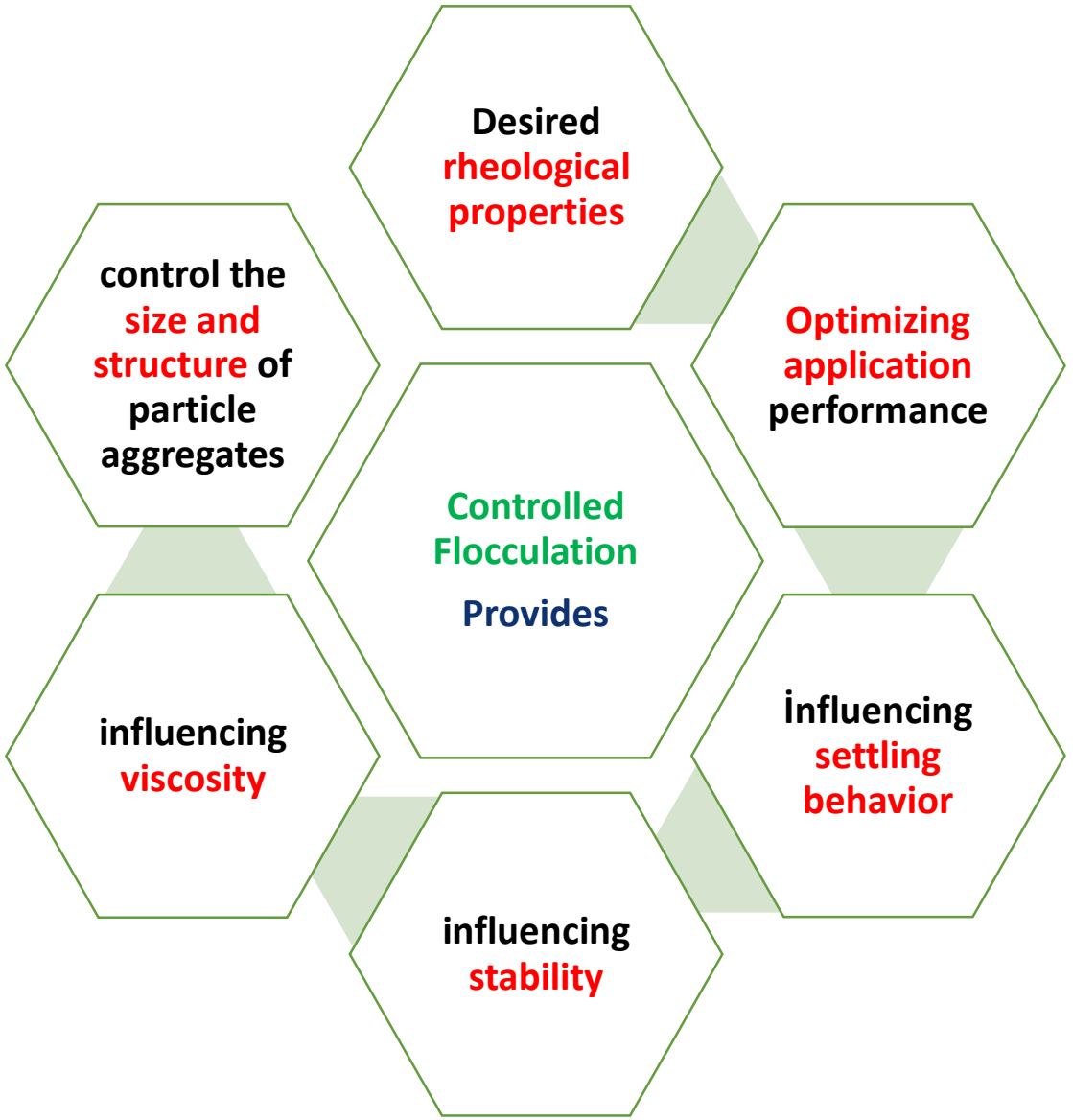


Fig. 1: Visiual explanation of reversible aggregation in presence of controlled flocculation

Reversible Aggregation:
With time, aggregation starts but can be removed by simple strring.


Desired rheological properties
control the size and structure of particle aggregates
Optimizing application performance
Controlled Flocculation
Provides
influencing viscosity
İnfluencing settling behavior
influencing stability

Importance of Controlled Flocculation

controlled flocculation agents contribute to improved application properties, storage stability, and overall coating performance. This is particularly important in formulations where a balance between viscosity and ease of application is crucial.

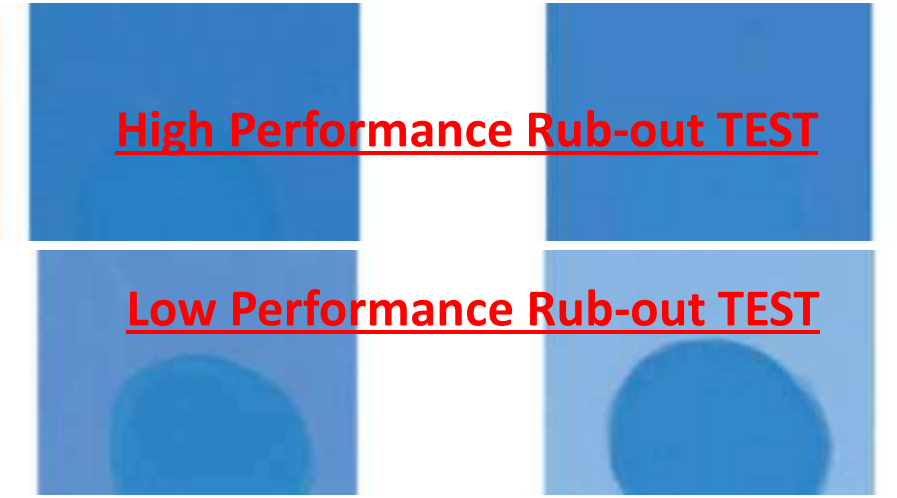
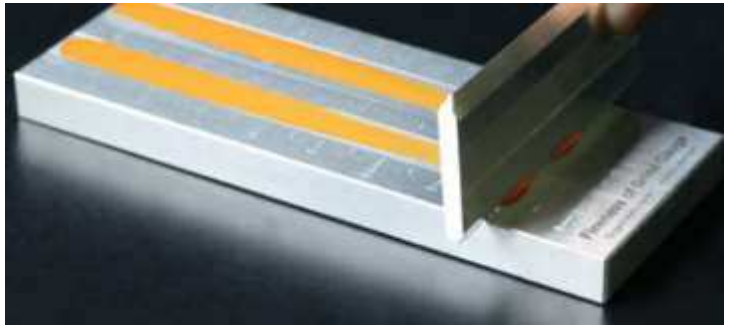


Fig. 2: Rub-out testing Results as an example



Controlled Finnes of Grinding Performance

Fig. 3: Visual Explanation forFineness of Grinding Testing

Desired Sagging Performance by Adjusting Rheology

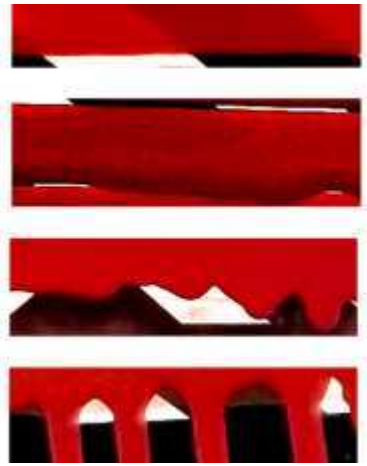
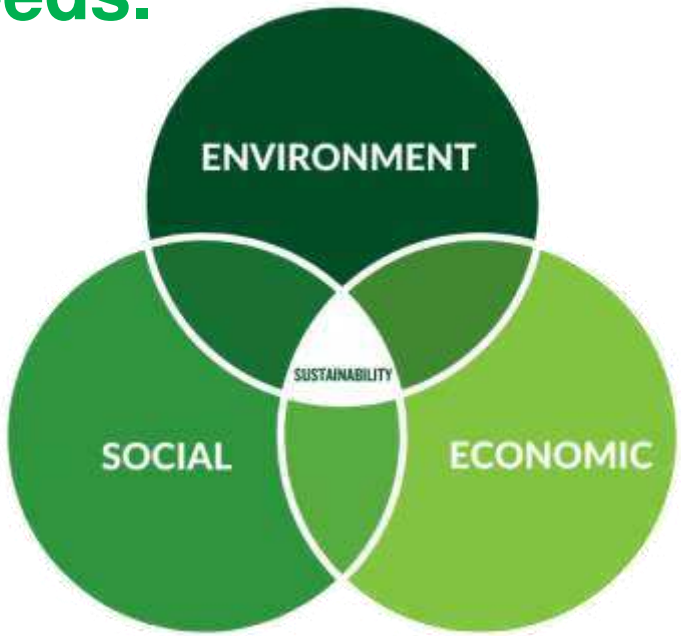
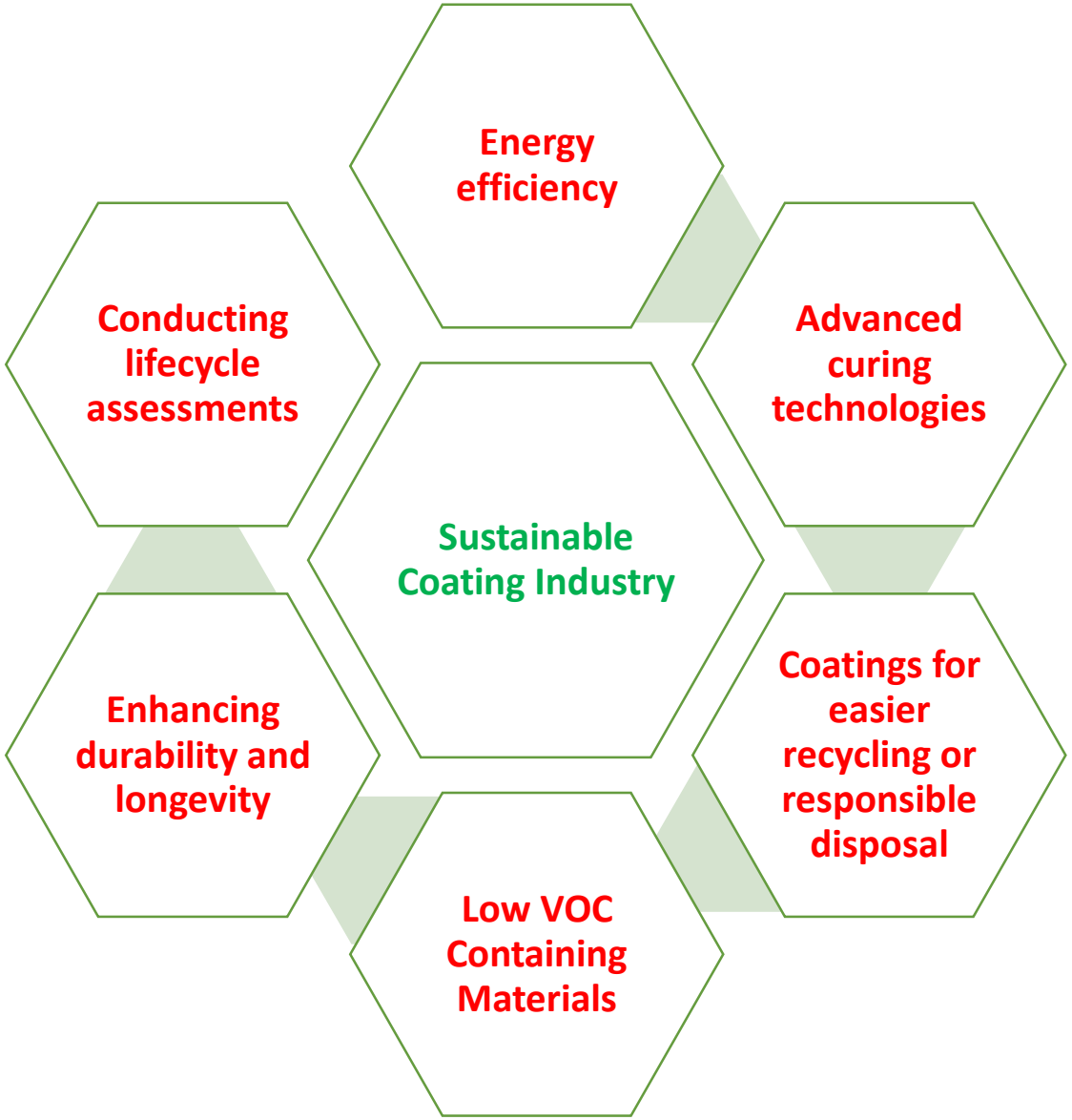


Fig. 4: Sagging Test for Paints (Prediction of sag resistance in paints using rheological measurements, Chang-Sheng Wang)

Brief Explanation About **SUSTAINABILITY**

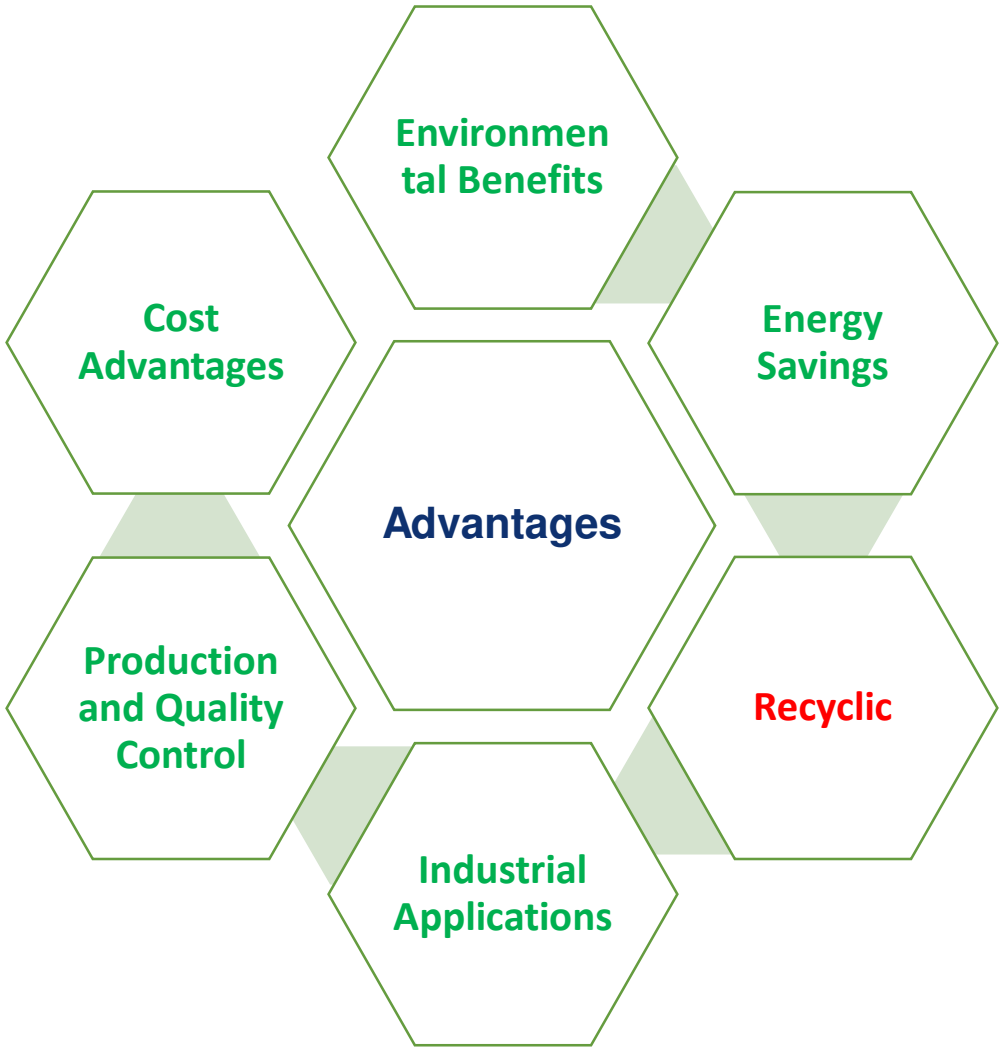
Sustainability is a concept that involves meeting the **needs of the present** without compromising the ability of **future generations to meet their own needs.**




Energy efficiency
Conducting lifecycle assessments
Advanced curing technologies
Sustainable Coating Industry
Enhancing durability and longevity
Coatings for easier recycling or responsible disposal
Low VOC Containing Materials

Sustainability In **Coating Industries**

In the coating industry, sustainability is achieved through **environmentally friendly formulations**, such as **low-VOC and water-based coatings**, and the use of **sustainably sourced and recycled materials.**


Environmental Benefits
Cost Advantages
Energy Savings
Advantages
Production and Quality Control
Recyclic
Industrial Applications

Sustainably Sourced and Recycled Materials

The reuse of waste oils and fatty acids in the coating sector plays a significant role as part of **environmentally friendly practices and sustainability efforts.** Recycling these materials offers various advantages.

Sustainably Sourced and Recycled Materials

The **reuse of waste oils and fatty acids** may pose certain technical and regulatory **challenges**. Ensuring the quality and suitability of the material, **process efficiency, and compliance with environmental regulations are critical factors.**

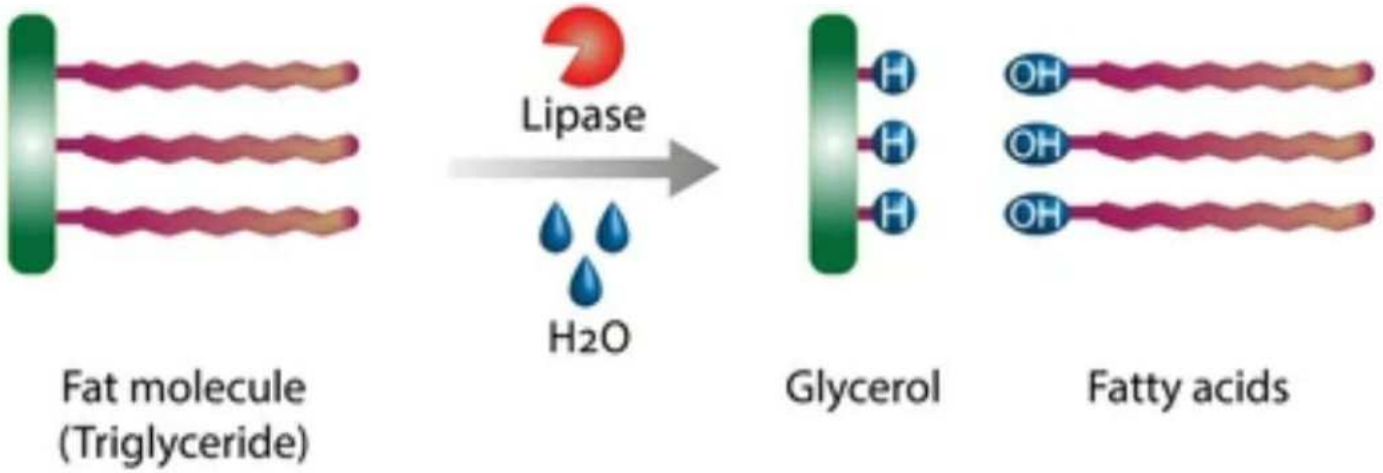
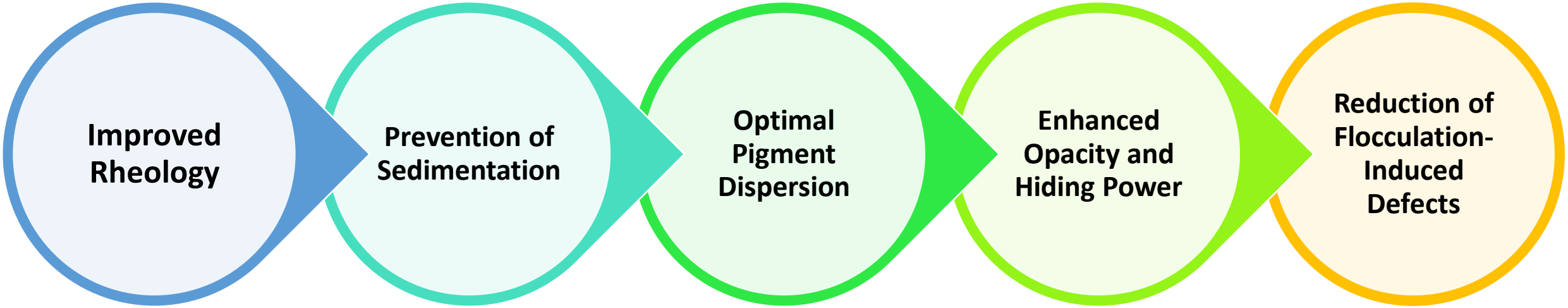


Fig. 5: A basic synthesis route for converting waste oil into fatty acids.

Importance of Controlled Floccultion For TiO_2

Controlled flocculation is of significant importance in titanium dioxide (TiO_2) containing coating systems due to its impact on various aspects of the coating's **performance**, **application**, and **appearance**.

Importance of Controlled Floccultion For TiO_2



Importance of Controlled Floccultion For TiO_2

It allows for the efficient use of pigments, **maintains consistent color and opacity**, and ensures that the coating can be applied with ease and precision across various applications.

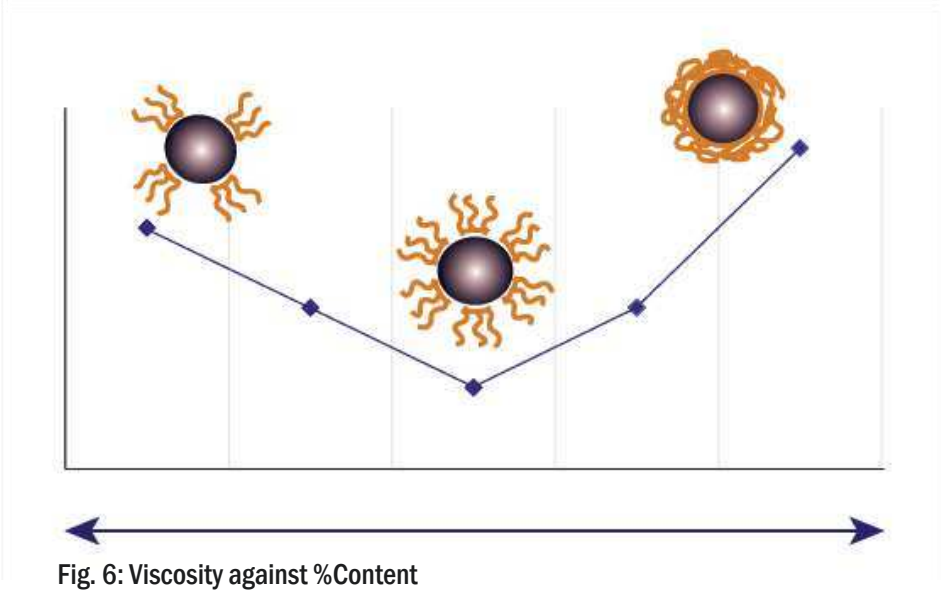


Fig. 6: Viscosity against %Content Controlled Flocculation Agent

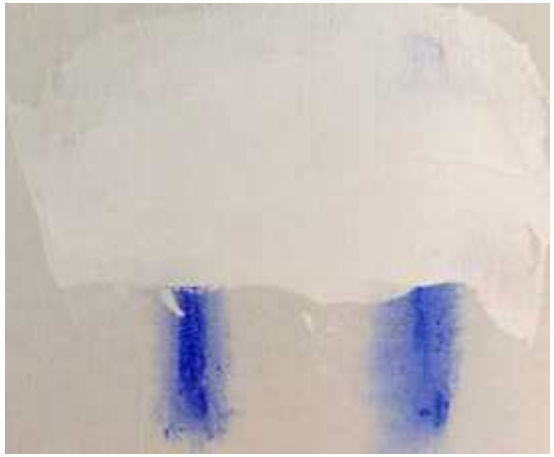
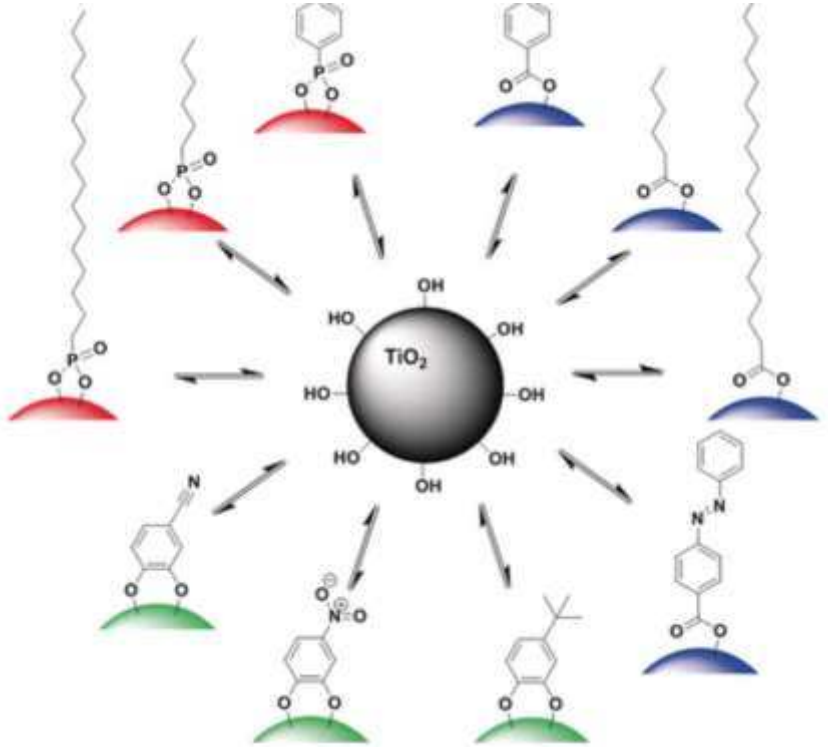


Fig. 7: RequiredCoverage Performance

Fig. 8: True Colour Appearence

Interaction Between TiO2 and Functional Materials



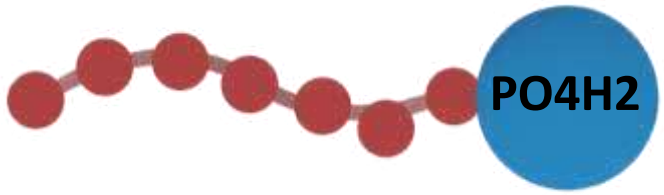
Lewis Acid-Base Interactions: TiO_2, with its surface hydroxyl groups, can act as a Lewis base, and certain Lewis acids can coordinate with these sites. This interaction involves the donation of electron pairs from the oxygen atoms of TiO_2 to the Lewis acid, forming coordination complexes on the surface.

Adsoption on Titanium Dioxide Surface

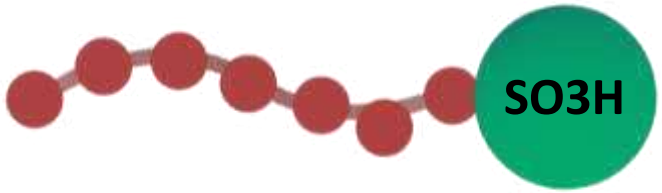
Fig. 9:Quantitative Determination and Comparison of the Surface Binding of Phosphonic Acid, Carboxylic Acid, and Catechol Ligands on TiO_2 Nanoparticles, Dr. Lukas Zeininger, Luis Portilla, Prof. Dr. Marcus Halik, Prof. Dr. Andreas Hirsch.

Possible Recycled Materials

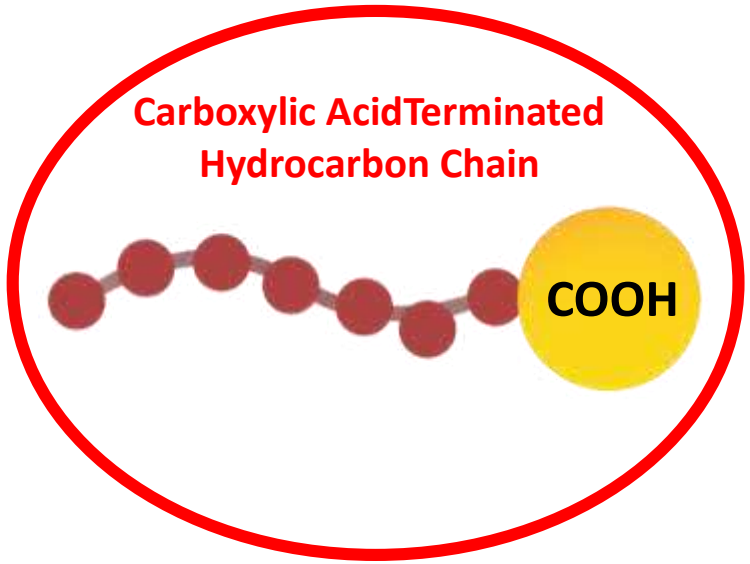
The concept of recyclable Lewis acids is an important aspect of **green and sustainable chemistry**, aiming to reduce waste and improve the environmental impact of chemical processes.



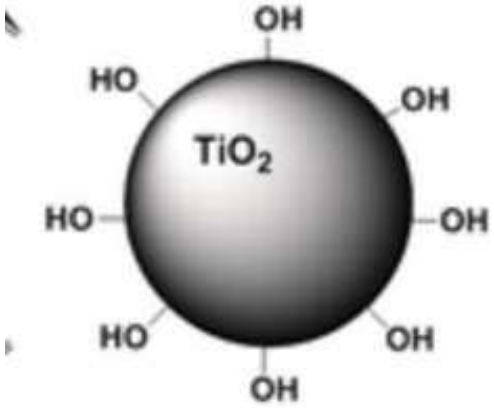
Phosphoric Acid Terminated Hydrocarbon Chain



Sulfonic AcidTerminated Hydrocarbon Chain

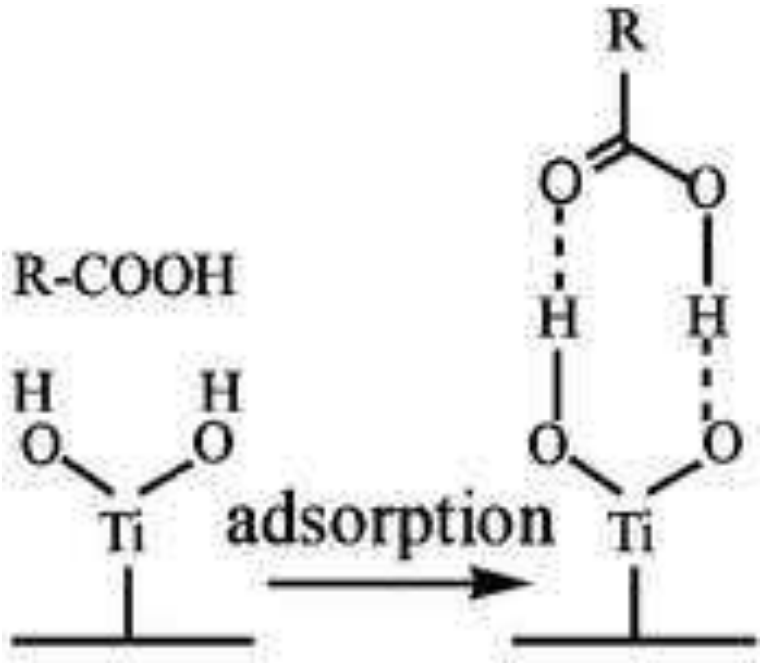


Interaction Between TiO2 and Carboxylic Acid



Surface of
The Titanium Dioxide
Particle

Carboxylic Acid is **Adsorbed**
on TiO_2 Surface

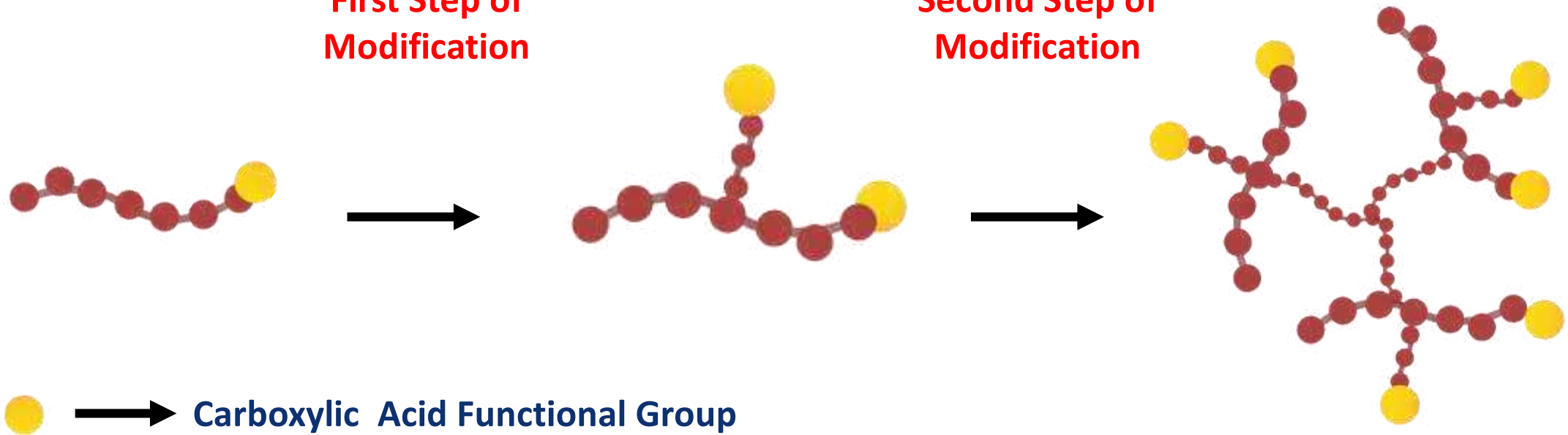


Ref: Chemically Binding Carboxylic Acids onto TiO2 Nanoparticles with Adjustable Coverage by Solvothermal Strategy, Qiyun Qu, Hongwei Geng, Ruixiang Peng, Qi Cui, Xiaohong Gu, Fanqing Li, and Mingtai Wang

Synthesis Route of Controlled Flocculation Agent

First Step of Modification

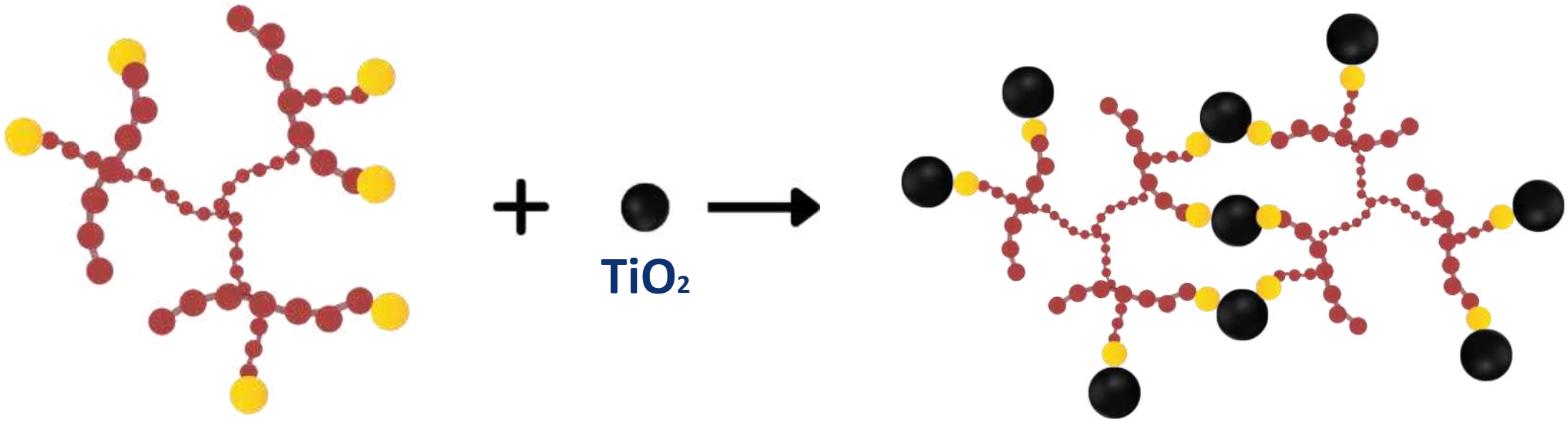
Second Step of Modification



Carboxylic Acid Functional Group

Hydrocarbon Chain

Creating 3D Network Structure



Controlled Flocculation Agent

3D Network Between Particle and Controlled Flocculation Agent

Fineness of Grinding & Viscosity

PRODUCT	t=t0	t= 2week		t= 4week	
	20°C	20°C	50°C	20°C	50°C
DENSURF	2500	4200	5000	6000	>6000
BENCHMARK	2400	4400	5200	6000	>6000

Table 1. Viscosity Measurement (mPa.s)

PRODUCT	t=t0	t= 2week		t= 4week	
	20°C	20°C	50°C	20°C	50°C
DENSURF	15	15	15	25	30
BENCHMARK	15	20	25	25	30

Table 2. Finnes of Grinding (µm)

Sagging Test Results

BENCHMARK

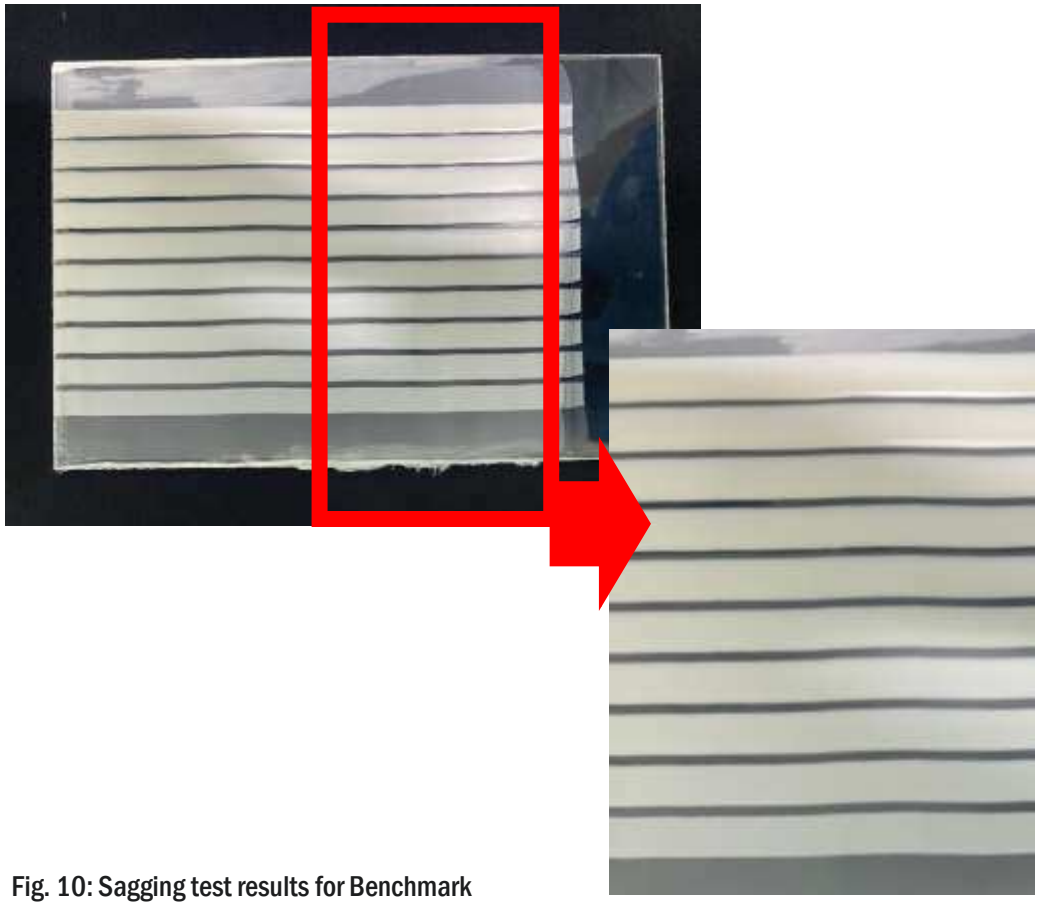


Fig. 10: Sagging test results for Benchmark

DENSURF

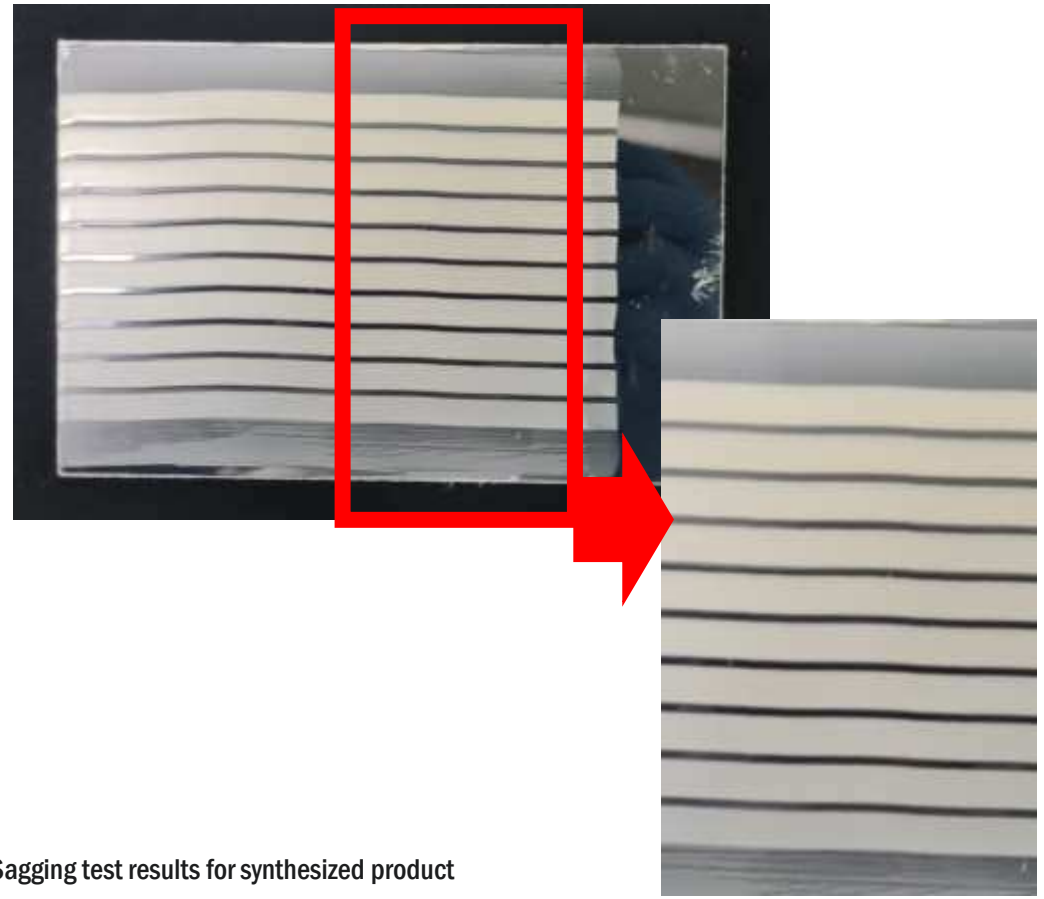


Fig. 11: Sagging test results for synthesized product

Coverage Test

BENCHMARK

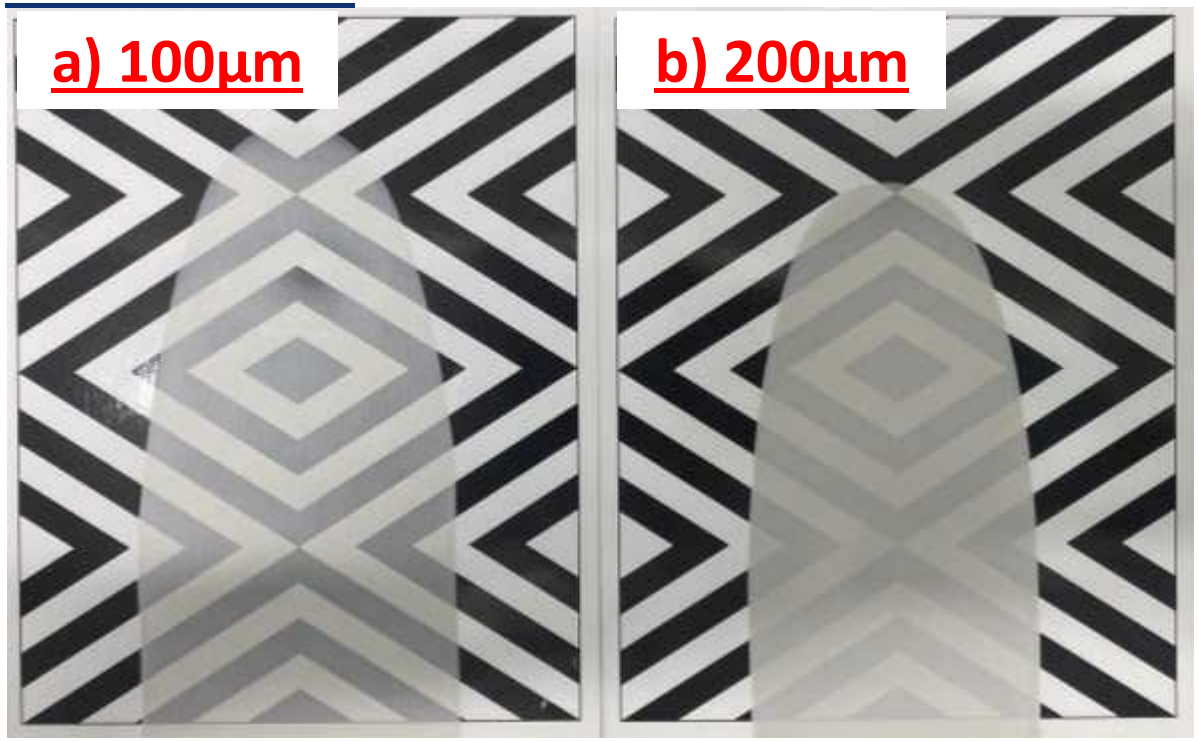


Fig. 12: Coverage test results for Benchmark a) for 100µm, b) for 200µm.

DENSURF

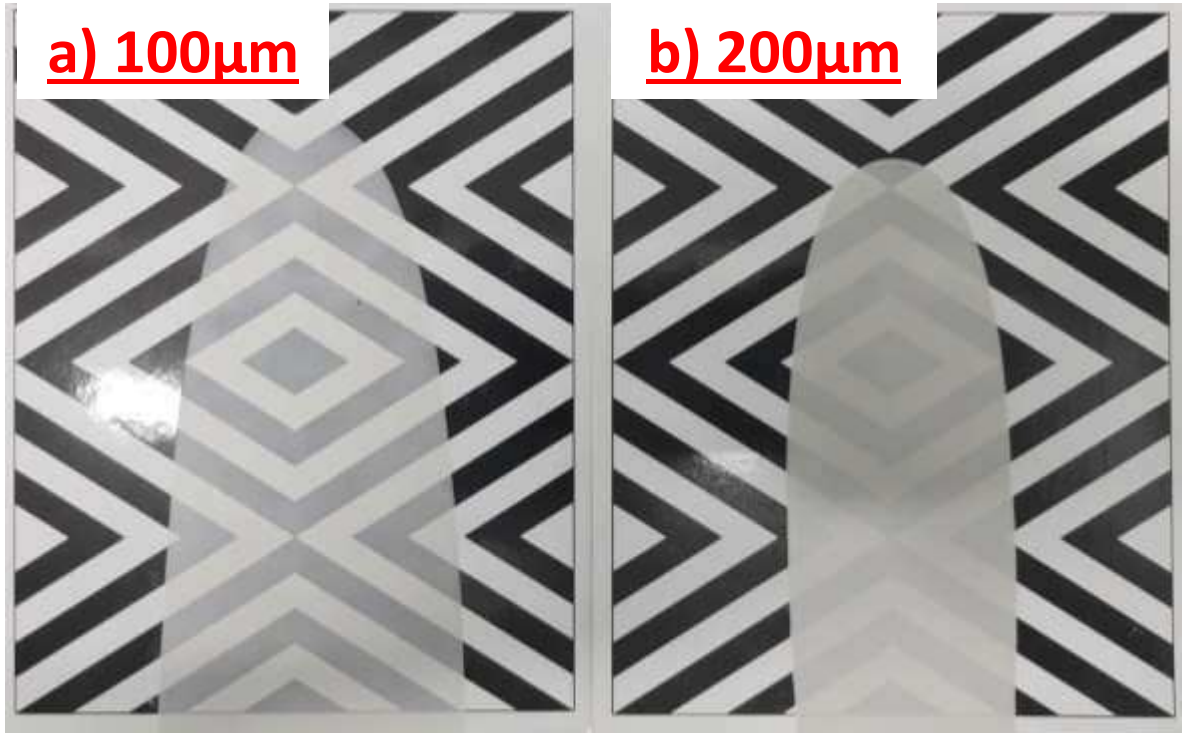


Fig. 13: Coverage test results for synthesized product a) for 100µm, b) for 200µm.

Layer by Layer Application

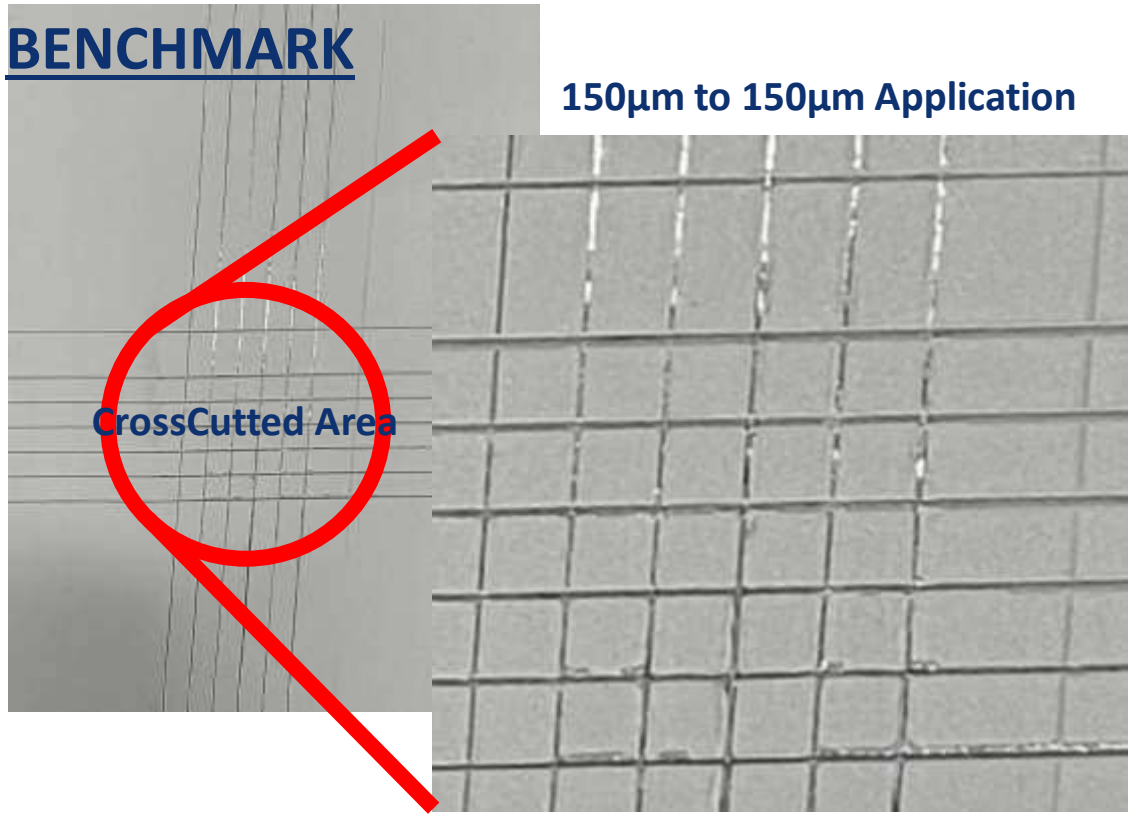


Fig. 14: Cross-cut test ruslts for layer by layer application of benchmark (2 layer applied)

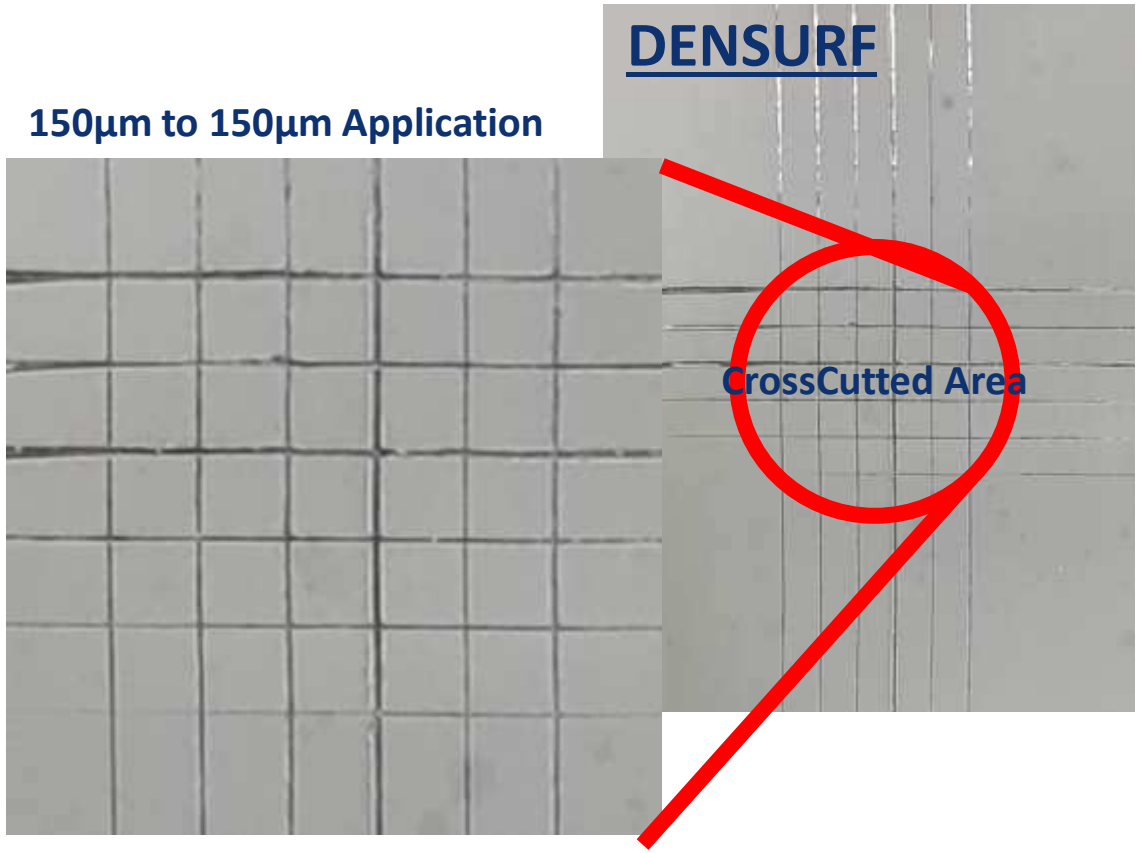


Fig. 15: Cross-cut test ruslts for layer by layer application of synthesized product (2 layer applied)

Conclusion

As an additive, usage of controlled flocculation agents **have crucial role** in the paint and coating industry.

To be a sustainable prroducer in the paint and coating industry, ***usage of recyled materials is one of the best option*** at the beginning.

Synthesized sustainable controlled flocculation agent in this study **exhibits well performance** and can be a ***new raw material with its sustainable feature.***

denge

CHEMISTRY FOR A BETTER FUTURE

R&D SUBJECTS

Silicone Copolymers

Water-Born Polyurethane Dispersions

Special Solutions For Textile Industry

Slicone Resins

Slicone Softener Emulsion

Additive For Coating Industries

densurf

COATING ADDITIVES & SILICONE RESINS

PRODUCT GROUPS

DA
DISPERSING AGENTS

AF
DEFOAMERS & AIR RELEASE AGENTS

SM
SURFACE MODIFIERS

HR
SILICONE RESINS

BOSAD BOYA SANAYİCİLERİ DERNEĞİ THE ASSOCIATION OF PAINT INDUSTRY 2003-2023 20

paintistanbul TURKCOAT CONGRESS

ChemMedia by Artkim Group

paintistanbul TURKCOAT CONGRESS

THANK YOU FOR YOUR ATTENDACE