



CARBOHYDE
REVOLUTION OF
CYCLODEXTRINS

Cyclodextrins

Application In Cosmetics



Reasons for Popularity of Cosmetics

Enhancing Appearance

- Evening out skin tone
- Achieving a certain look
- Makeup, hair styling products



Enhancing Skincare & Health Benefits

- Maintaining skin health
- Preventing damage,
- Curing concerns such as dryness, acne, or sensitivity



Hygiene and Grooming

- Maintaining cleanliness
- Pleasant appearance
- Deodorants, perfumes, and oral care

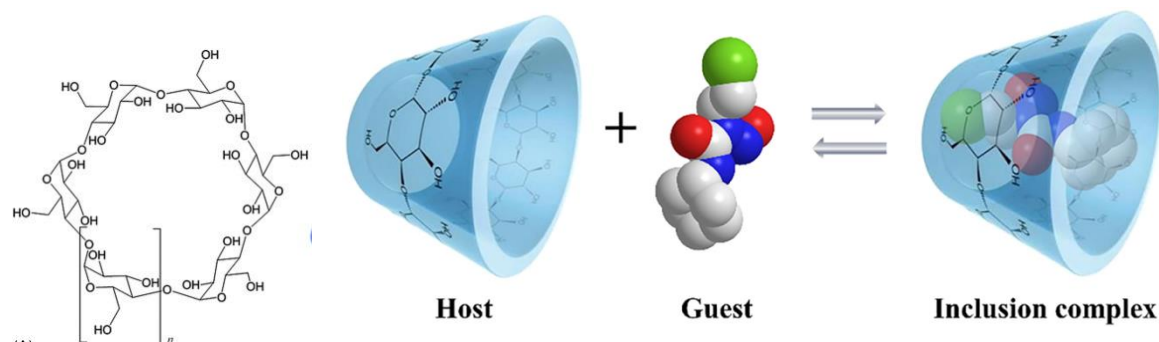




What are Cyclodextrins (CDs)?

Properties and structure

- Naturally occurring cyclic molecules composed of sugars
- Safe to use
- Used in food, cosmetics & hygiene, pharmaceuticals, agriculture, etc.
- Sub-nanometer sized molecular containers with hydrophilic outer phase and hydrophobic interior properties
- Reversible inclusion complex formation



Medicine



Household



Food &
Drinks



Agriculture



Cosmetics



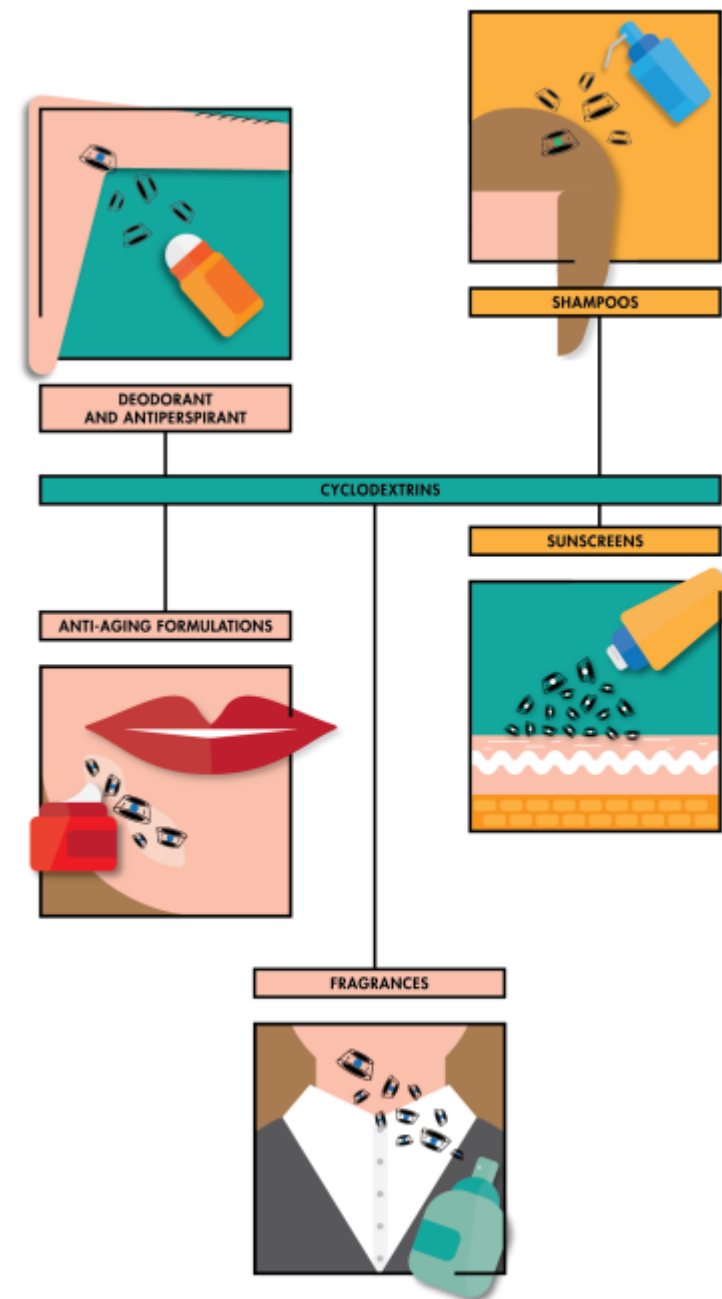
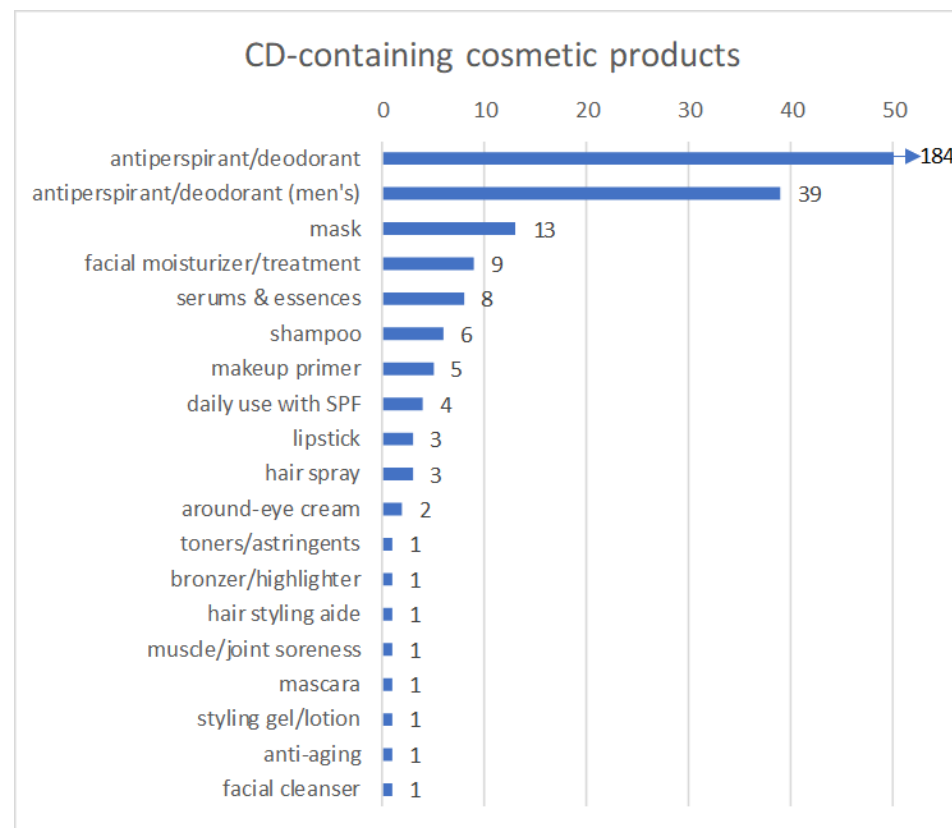
Improved formulations: Cosmetics

CD used:

mainly HPBCD and RAMEB

Purpose:

- Stabilization
- Emulsifier
- Solubilizer
- Improved bioavailability



Cosmetic formulations containing CDs



Advantages of CDs in Cosmetics

Solubilizing properties

- Insoluble compounds can be **dissolved** via CD complexation **without** the use of **organic co-solvents or surfactants**
- **Easier to incorporate** into formulations
- **Change in viscosity** of formulations is possible
- **Aqueous products** to moisturize the epidermis in depth without making it greasy

Stabilizing properties

- **Protection** of light- and/or oxygen-sensitive substances
- **Longer** expiration time, shelf life



Process improvement

- Conversion of **liquids and oily materials** into powders results in easier handling
- Increase of **emulsions and suspensions stability**
- **Incompatible compounds** can be mixed and used together in complexed form.



Advantages of CDs in Cosmetics

Controlled release of fragrances

- Volatility suppression
- **Long-lasting fragrances**
- Perfumes, room fresheners and detergents, diapers, menstrual products, paper towels, etc.

Masking odors and taste

- Unfavorable **organoleptic characteristics** of some substances of the product **can be covered**
- CDs released into the environment can **bind molecules in the air/surface**, neutralising their odor

Preventing skin irritation

- CDs **alleviate local irritation** and reduce other side effects
- CDs increase the permeation of active ingredients and exhibit benefits over conventional penetration enhancers, such as fatty acids and surfactants





Regulatory status of CDs

United States of America

- Alpha-CD, beta-CD and gamma-CD are considered as GRAS (Generally Recognized as Safe) ingredients
- HPBCD and methylated CDs are the most commonly used due to their absorption enhancing properties
- Regulatory organisation: FDA
- Compliance with cGMP is mandatory



European Union

- None of cyclodextrins among is categorized in the Cosmetic Ingredient Database (CosIng) as banned or restricted in (EC) No. 1223/2009
- β -Cyclodextrin (CAS 7585-39-9) is explicitly listed in the CosIng without specific restrictions
- Compliance with GMP is mandatory (based on the requirements of ISO 22716:2007 - The Official GMP Standard for Cosmetics)

Cosmetic Ingredient Review (CIR)

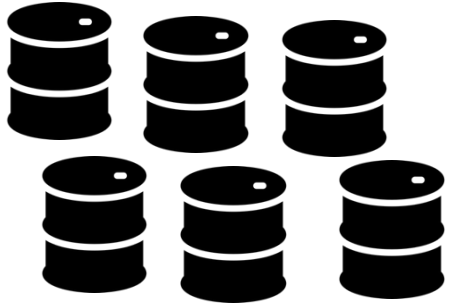
Safe CDs accoring to CIR Expert Panel:

- Cyclodextrin
- Hydroxyethyl Cyclodextrin
- Hydroxypropyl Cyclodextrin
- Cyclodextrin Laurate
- Methyl Cyclodextrin
- Cyclodextrin Hydroxypropyltrimonium Chloride



The Power of Cyclodextrins

Solubilization of coenzyme Q10 (CoQ10)

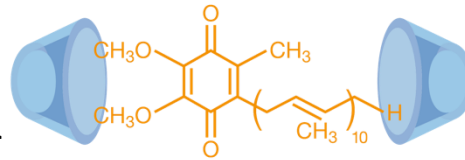


Without CD: 1000 L water
dissolves 100 µg CoQ10



With GCD: 0.25 mL water
dissolves 100 µg CoQ10

**CAVAQ10® CoQ10
Complex:** a product
based on these findings



Fir, M. M., et al. (2009). Journal of Inclusion Phenomena and Macrocyclic Chemistry, 64, 225-232.
Žmitek, J., et al. (2008). Annals of Nutrition and Metabolism, 52(4), 281-287.

Stability increase: ketoconazole



Without CD: 39%
degradation in 8 months

Che, J., et al. (2015). European Journal of Pharmaceutics and Biopharmaceutics, 93, 136-148.

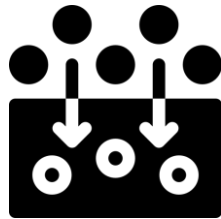


Product with HPBCD:
7% degradation in 8
months

Penetration enhancement: nicotine



Without CD: 0.95 µg



With BCD: 13.57 µg

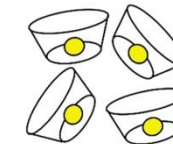
Potential products:
- Transdermal patch
- Shampoos



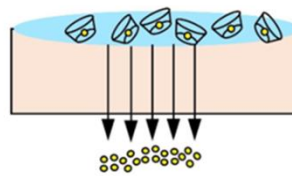
βCD and MβCD
(Host molecules)



Nicotine
(Guest molecules)



Inclusion complexes



Skin permeation study



CDs in Cosmetics Homecare

(Hydroxypropyl) Cyclodextrin

You know it as: a product made from sweet summer corn and potatoes

What it does: traps odors and locks them away (not just covering them up!)

Used in: Fabric Refresher, Air Effects

P&G has been awarded **over 200 patents** on the application of CDs in fabric, homecare and health, beauty care





CDs in Cosmetics Fragrances

CD use in fragrances

- Odor Control: neutralization of undesirable smells, helping to maintain a fresh scent for longer.
- Stabilization: stabilization of volatile fragrance compounds, reducing evaporation and making the scent last longer.
- Slow Release: controlled release of fragrance.



Product "Adidas UEFA Best of the Best Eau de Toilette" containing methyl CD



Product "Mexx Fresh Splash For Him" containing methyl CD



Deodorant containing CD due to its chelating properties



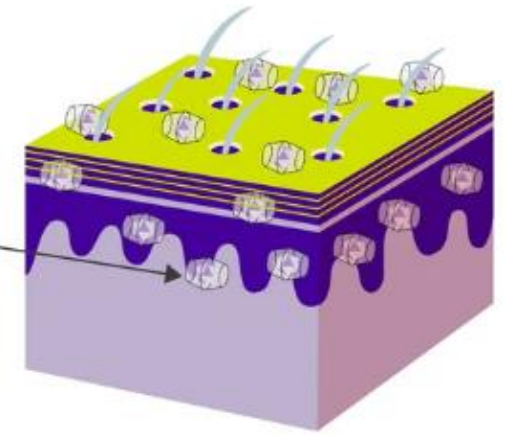
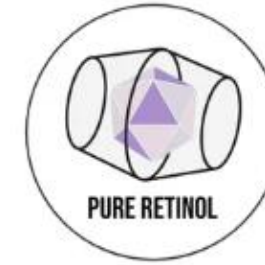
Deodorant containing CD due to prolong fragrance release



CDs in Cosmetics Skincare

Pro-retinoid containing products

Popular pro-retinoids like retinal and retinol are chemically unstable and exhibit extremely low aqueous solubility, therefore emulsion is required. Use of CD ensures better stability of this sensitive materials because hydrophobic ingredients such as retinal "hide" inside leading to slower oxidation process and solubility enhancement.



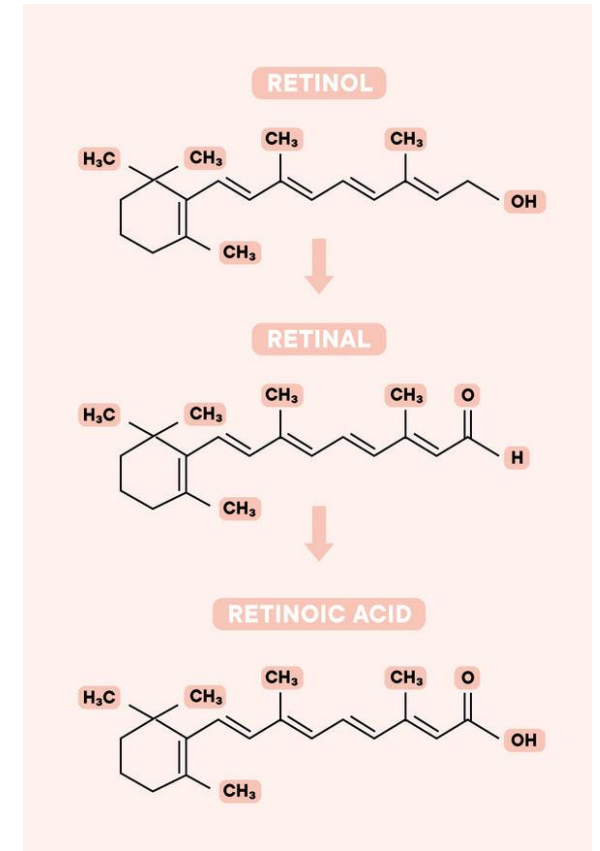
Facial emulsion with 0.1% of retinal and CD



Concentrate with 10% CD-retinol complex (retinol content:0.3%)



Retinol cream with CD (concentration undefined)

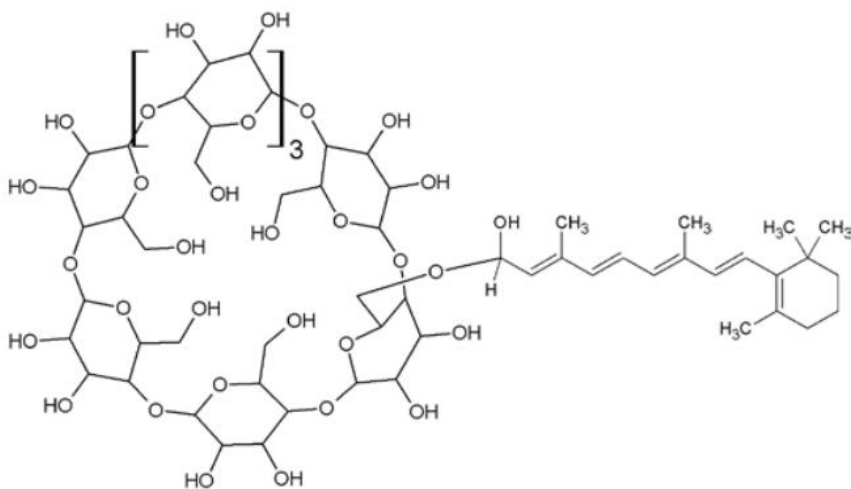




CDs in Cosmetics Skincare

Conjugation of retinal/retinaldehyde

Retinal γ -Cyclodextrin Hemiacetal (RCH) is an innovative delivery system for retinal. Despite being the most bioavailable form of Vitamin A, retinal has seen limited use due to its extreme instability. This new delivery system leverages a “transient” hemiacetal bond to stabilize retinal for cosmetic applications. At the core of Iconica[®], the hemiacetal bond maintains RAL in a stabilized state through an unusual emulsification process.



Structure of RCH



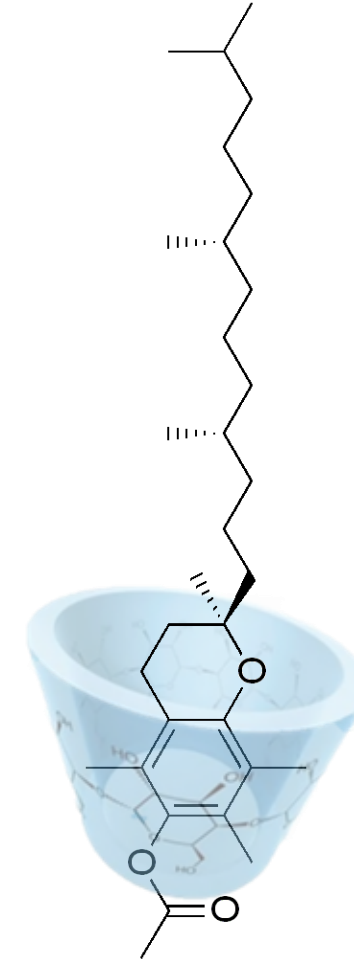
Product containing RCH
(GCD-retinal conjugate)



CDs in Cosmetics Skincare

Vitamin E: active ingredient against oxidative damage

Vitamin E and its antioxidant properties are utilised by the skin to help protect your body against environmental sources of oxidative damage, including UV rays from the sun and air pollutants. It exhibits low aqueous solubility and instability which requires solubilization techniques.



15% Vitamin E Acetate Cyclosystem Complex® using BCD (encapsulated vitamin E acetate content: 13-17%)

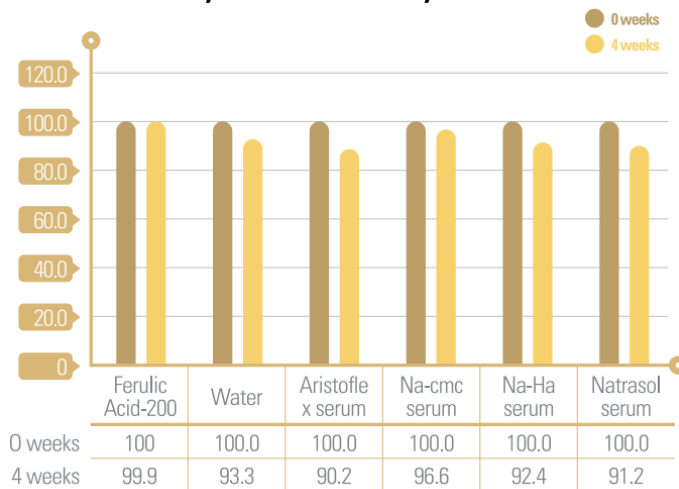


CDs in Cosmetics Skincare

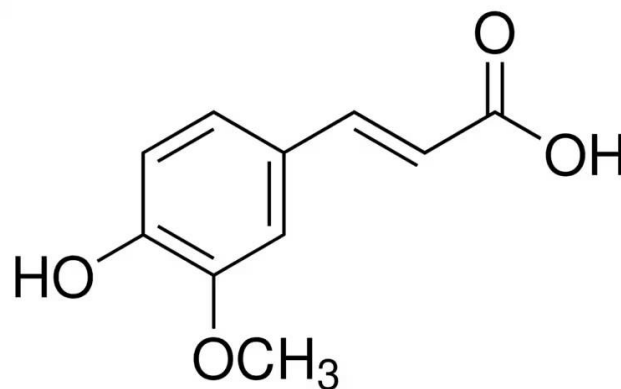
Ferulic acid: a potent antioxidant

An antioxidant that protects the skin from free radicals and enhances the effects of other antioxidants like vitamins C and E. It's particularly noted for its role in combating premature skin aging.

Ferulic acid is poorly soluble, BioGenic Ferulic Acid-200 utilizes HPBCD to enhance its solubility and stability. Stable for 4 weeks, it degrades in 1 day without CD.



Thermal stability of BioGenic Ferulic Acid-200 at 50 °C



Structure of ferulic acid



BioGenic Ferulic Acid-200:
1 % of ferulic acid concentration
achieved with HPBCD

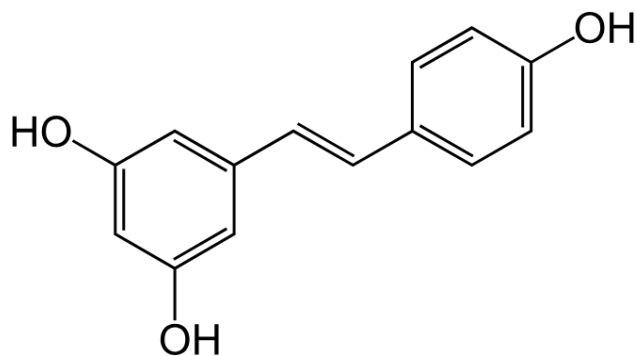


CDs in Cosmetics Skincare

Resveratrol: anti-aging active ingredient

Resveratrol is a phenolic phytoalexin found in grape skin and other plants. This natural deodorizing agent exhibits antioxidant activity and claimed to be powerful anti-aging in a stable form. Resveratrol soothes inflammation and promotes even skin tone as well as provides antimicrobial benefits.

A product called "iActive Resveratrol" contains encapsulated resveratrol with HPBCD.



Structure of resveratrol



Resveratrol concentrate containing iActive Resveratrol



CDs in Cosmetics Haircare



Shampoo and sprays:
Emulsifier effect of CD

CDs role in shampoos

- Odor Control
- Enhanced Solubility and Stability
- Controlled Release
- Sebum & Oil Absorption



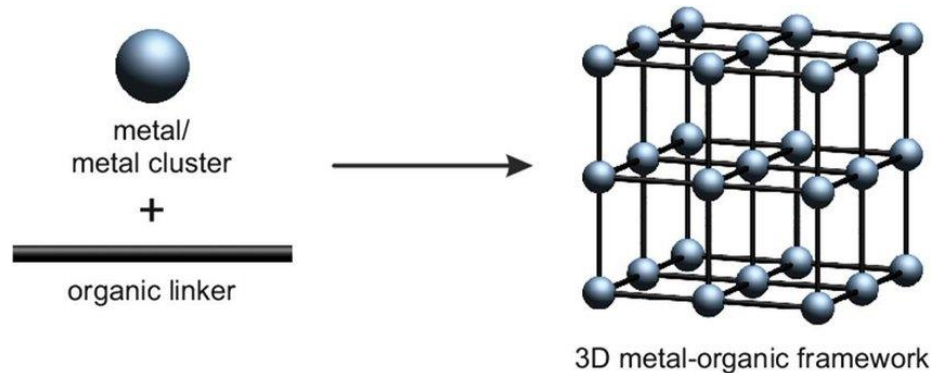
Product containing CD to absorb
excess oil on the scalp.



Metal-Organic Frameworks-based product from a Nobel Laureate

Metal-Organic Frameworks (MOFs)

- Materials composed of **metal ions** or clusters connected by **organic molecules (linkers)**, like CDs
- Cage-like structure with tunable porosity and high surface area



Schematic figure of MOFs

CD-based Metal-organic framework

Organic Supramolecular Vessels™ (OSV™) by Nobel laureate in Chemistry, Sir Fraser Stoddart.

Purposes:

High extent of complexation
Controllable release
Targeted delivery

Products:

Serums
Day Moisturizers
Night Moisturizers
Eye Care
Refills
Mask
Sets





Utility of Cyclodextrins in Cosmetics

The possibilities are...

- **Vitamin C serums:** Cyclodextrins are often used to stabilize and solubilize vitamin C in serums, which helps to improve its effectiveness in brightening and evening out the skin tone.
- **Retinol creams:** Cyclodextrins help to protect retinol from degradation and improve its stability, which can lead to better anti-aging results in creams and lotions.
- **Essential oil hair treatments:** Cyclodextrins can be used to encapsulate essential oils in hair treatments, which can help to protect the oils from oxidation and improve their efficacy in nourishing and strengthening the hair.
- **Natural extract moisturizers:** Cyclodextrins can be used to solubilize and stabilize natural plant extracts in moisturizers, which can help to enhance their moisturizing and antioxidant properties.
- **Sunscreen formulations:** Cyclodextrins can be used in sunscreen formulations to encapsulate UV filters, which can help to improve their stability and reduce skin irritation.

...endless.



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For any questions:

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