The Formulators LAB. + JOAN MORAIS COSMETICS SCHOOL

LAMELLAR LIQUID CRYSTAL STRUCTURES

A Formulator's Guide to Skin and Hair Care Applications

What Is a Lamellar Liquid Crystal Structure?

A lamellar liquid crystal structure is an organized arrangement of alternating **lipid and water layers** within a cosmetic formulation.

The word **lamellar** means layered.

The structure can be visualized as:

Lipid layer → Water layer → Lipid layer → Water layer

These layers remain flexible and mobile, which is why they are described as liquid crystals rather than solid crystals.

Why Lamellar Structure Matters

A lamellar structure can influence how a formulation:

- Maintains stability
- Holds water
- Builds viscosity
- Spreads on the skin or hair
- Deposits conditioning ingredients
- Releases active ingredients
- Feels during and after application

A thick cream is not automatically lamellar. Gums, waxes and fatty alcohols can increase viscosity without creating an organized liquid crystal structure.

WHAT IT DOES IN A FORMULATION

1. Supports Emulsion Stability

Lamellar layers can create a structured network around oil droplets and throughout the water phase.

This may help reduce:

- Separation
- Creaming
- Oil-droplet movement
- Coalescence
- Uneven ingredient distribution
- Rapid viscosity changes

Lamellar structure supports stability, but it does not replace proper emulsifier selection, preservation or stability testing.

2. Creates Body and Texture

Lamellar gel networks can give creams and conditioners a:

- Creamy texture
- Cushioned feel
- Rich body
- Smooth application
- Elegant slip
- Substantial feel without excessive greasiness

The formulation may feel firm in the container but become easier to spread when rubbed onto the skin or hair.

3. Holds Water Within the Formula

Water can become positioned between the lipid layers.

This allows the lamellar network to act like a microscopic water reservoir, helping the formulation retain water and provide a more hydrated feel.

4. Helps Distribute Ingredients

Lamellar systems contain both water-compatible and oil-compatible regions.

This may help organize and distribute:

- Emollients
- Humectants
- Lipids
- Conditioning agents
- Oil-soluble actives
- Water-soluble actives

A lamellar structure does not automatically increase penetration. Ingredient delivery depends on the entire formulation.

WHAT IT DOES ON THE SKIN

The outer layer of the skin contains naturally organized layers of:

- Ceramides
- Cholesterol
- Fatty acids
- Other skin lipids

Because lamellar emulsions also contain layered lipid structures, they may have a strong affinity for the skin surface.

This is why some lamellar emulsions are described as **biomimetic** or skin compatible.

Potential Skin Benefits

A properly formulated lamellar emulsion may help:

- Improve skin hydration
- Reduce moisture loss
- Smooth the skin surface
- Distribute emollients evenly
- Support dry or compromised skin
- Improve softness and flexibility
- Create a protective surface layer
- Support skin-barrier comfort

Important Formulation Note

The structure alone does not repair the skin.

The lipid composition also matters. A lamellar cream containing appropriate ceramides, sterols, fatty acids and emollients may perform differently from a simple emulsifier-and-fatty-alcohol system.

It is more accurate to say that a lamellar formula can **support the skin barrier** rather than claim that it permanently rebuilds or replaces it.

WHAT IT DOES ON THE HAIR

Lamellar structures are commonly formed in:

- Hair conditioners
- Hair masks
- Deep treatments
- Leave-in conditioners
- Intensive conditioning products

In many conditioners, a cationic conditioning ingredient combines with fatty alcohols and water to form a lamellar gel network.

What the Structure Does in a Conditioner

The lamellar network can provide:

- Creamy viscosity
- Product stability
- Even spreading
- Controlled ingredient distribution
- Good rinse behavior
- A rich and conditioned application

Potential Hair Benefits

Once conditioning ingredients deposit on the hair, they may help:

- Reduce friction
- Improve wet combing
- Improve dry combing
- Reduce static
- Smooth the cuticle surface
- Improve softness

- Increase manageability
- Reduce roughness
- Improve the feel of porous or damaged hair

Hair is a nonliving fiber. A conditioner can coat, smooth, lubricate and protect the hair, but it cannot permanently biologically repair it.

SKIN AND HAIR LAMELLAR SYSTEMS ARE DIFFERENT

A skin cream and a hair conditioner may both contain lamellar structures, but they are usually created with different ingredients.

Skin-Care Lamellar Systems May Include

- Nonionic emulsifiers
- Glyceryl esters
- Phospholipids
- Fatty alcohols
- Ceramides
- Plant-derived lipids
- Sterols
- Fatty acids

Hair-Care Lamellar Systems May Include

- Cationic surfactants
- Conditioning emulsifiers
- Cetyl alcohol
- Cetearyl alcohol
- Stearyl alcohol
- Oils and esters
- Conditioning polymers

Skin formulations are generally designed for hydration, emolliency and barrier support.

Hair formulations are generally designed for deposition, lubrication, detangling and manageability.

HOW LAMELLAR STRUCTURES FORM

Lamellar structures form through **self-assembly**.

The emulsifier or surfactant molecules contain:

- A water-compatible portion
- An oil-compatible portion

Under the correct conditions, the molecules align and organize into repeating layers.

Factors That Influence Formation

- Emulsifier type
- Surfactant structure
- Fatty alcohol type
- Emulsifier-to-fatty-alcohol ratio
- Oil-phase composition
- Water content
- Electrolytes
- Polymers and gums
- Heating temperature
- Mixing method
- Homogenization
- Cooling rate
- Agitation during cooling
- Final pH

GENERAL PROCESSING GUIDELINES

Always follow the emulsifier supplier's recommended procedure.

1. Prepare the Water Phase

Combine water and compatible water-soluble ingredients.

Heat to the required emulsification temperature.

2. Prepare the Oil Phase

Combine oils, emulsifier, fatty alcohols and other heat-stable oil-soluble ingredients.

Heat until completely melted and uniform.

3. Combine the Phases

Add one phase to the other according to the emulsifier instructions.

Mix or homogenize until the emulsion is properly formed.

4. Cool Under Controlled Mixing

Reduce the mixing speed when appropriate and continue stirring during cooling.

The lamellar structure often develops as the formulation cools and passes through specific phase-transition temperatures.

5. Add Cool-Down Ingredients

Add the preservative, fragrance, essential oils and heat-sensitive ingredients at their recommended temperatures.

Continue mixing until uniform.

PROCESSING CAUTIONS

Too Much Shear

Excessive high-shear mixing during the full cooling process may disrupt the developing structure.

Too Little Mixing

Inadequate mixing may result in uneven cooling, inconsistent viscosity or an irregular structure.

Cooling Too Quickly or Too Slowly

The cooling rate can influence the size, organization and uniformity of the lamellar network.

Changing Ingredients Without Retesting

Changing the oil, fatty alcohol, emulsifier or electrolyte level may alter:

- Viscosity
- Stability
- Texture
- Liquid crystal formation
- Skin feel
- Hair feel

HOW TO CONFIRM A LAMELLAR STRUCTURE

A formulation cannot be confirmed as lamellar by appearance alone.

Methods used to evaluate lamellar structures include:

- Polarized light microscopy
- Rheological analysis
- Differential scanning calorimetry
- Small-angle X-ray scattering

- Small-angle neutron scattering
- Electron microscopy

Under polarized light, some liquid crystal structures may display characteristic birefringent patterns. However, microscopy alone may not identify the exact structure.

COMMON MISCONCEPTIONS

“Every thick cream is lamellar.”

False. Thickness can come from gums, polymers, waxes or fatty alcohols without a true lamellar structure.

“A lamellar system automatically improves penetration.”

False. Delivery depends on the active ingredient and the entire formulation.

“Lamellar emulsions permanently repair skin.”

False. They may support hydration, surface lipids and barrier comfort, but they do not become new skin.

“Conditioners repair damaged hair.”

Not permanently. They improve the surface condition, lubrication and manageability of the hair fiber.

“Lamellar means natural.”

False. Lamellar describes molecular organization, not ingredient origin.

LAMELLAR STRUCTURES VS. LIPOSOMES

A liposome is a closed vesicle made from one or more lipid bilayers surrounding an internal water compartment.

A lamellar liquid crystal structure may exist as:

- Extended layered sheets
- Layers surrounding oil droplets
- Multilayered vesicles
- An interconnected gel network

Liposomes contain lamellar bilayers, but not every lamellar emulsion is a liposomal formulation.

FORMULATOR'S TAKEAWAY

Lamellar liquid crystal structures create an organized internal architecture within creams, lotions and conditioners.

In skin care, they may support:

- Hydration
- Water retention
- Barrier comfort
- Elegant texture
- Even lipid distribution

In hair care, they may support:

- Creamy structure
- Ingredient deposition
- Lubrication
- Detangling
- Manageability

Successful lamellar formulations depend on more than the emulsifier.

The Complete System Matters

Ingredient selection + ingredient ratios + processing + cooling + preservation + stability testing

A properly designed lamellar system can help transform a basic emulsion into a stable, elegant and high-performing skin or hair care formulation.

Continue Your Formulation Education

Learn how to select emulsifiers, design stable systems and create professional natural and vegan skin and hair care products with **The Formulators LAB by Joan Morais**.

Professional training in natural, vegan cosmetic formulation

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