

Small but powerful ingredients of eco-friendly coatings

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Pieter Samyn

How bio-based additives can cut carbon footprints and enhance performance

When you think about paint or protective coatings, you probably imagine color, shine, and other observable aspects. But one of the biggest challenges the coatings industry is facing nowadays, is less visible to the eye: **how to make these products eco-friendly without sacrificing performance**. The coating manufacturers need to become less reliant on petrochemical ingredients, which contribute to pollution and resource depletion. The good news? Scientists and engineers are finding ways to replace these fossil-based components with **bio-based alternatives** such as materials derived from plants, agricultural waste, or recycled resources.

One area that often gets overlooked is **additives**. These are the small but powerful ingredients that give coatings their special properties: scratch resistance, water repellence but also color. Even though additives make up only a small percentage of the formula, they can have a surprisingly big impact on the environment. So, what happens if we swap fossil-based additives for bio-based ones? Let’s dive into the science and see why this matters.

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How do additives make the difference?

So far, most sustainability efforts in coatings have focused on replacing the main ingredient, the **binder**, with bio-based versions. That's important because binders make up 70 to 80% of the coating. But additives, even in small amounts, also heavily influence performance and lifespan. A longer-lasting coating means fewer repairs and less waste, which is a win for the planet. Bio-based additives can contribute significantly to this equation.

Bio-based additives come from renewable sources like:

- **Rice husk biochar:** made by heating rice husks in low oxygen (pyrolysis)
- **Recovered calcium carbonate:** sourced from waste streams instead of virgin minerals
- **Biowax:** derived from plants instead of petroleum
- **Cork powder:** from cork waste
- **Nanocellulose:** tiny fibers from wood or recycled paper, used for strength

These additives can replace fossil-based ones like carbon black, silicates, and polyethylene wax. They offer similar functionality (abrasion resistance, color, hydrophobicity) and a significantly greener footprint.



A fresh approach: ab initio Life Cycle Analysis

But how do we measure the impact of bio-based additives? Life Cycle Analysis (LCA), a proven method for measuring environmental impact, rarely includes additives. Why? Because data is scarce, and the calculations are complex. This gap means we might be missing opportunities to make coatings greener.

Researchers at Sirris applied a simplified LCA method to tackle this issue. Instead of waiting for complete datasets (which can take years), they started from scratch using what scientists call an **“ab initio” approach**. They looked at the entire journey of an additive, from raw material to finished product, and compared fossil-based options with bio-based alternatives.

Using data from databases and best available approaches, researchers calculated eco-costs for different additives, including Carbon footprint (kg CO_2 equivalent), Human health impact, Eco-toxicity, Resource scarcity. The results? Bio-based additives like rice husk biochar and biowax consistently scored better than fossil-based ones. Even when extra processing was needed, the overall environmental impact was lower, especially when combined with bio-based binders.

For example:

- Replacing carbon black with rice husk biochar cut the carbon footprint by 14%
- Switching virgin calcium carbonate to recovered $CaCO_2$ saved up to 34%
- Using biowax instead of PE wax reduced emissions by 29% when paired with a bio-based binder

However, some bio-based additives need intensive processing. For example, turning wood pulp into nanocellulose requires a lot of energy: up to 108 MJ per kilogram! That's because breaking down cellulose fibers is tough work. So, while the raw material is renewable, the processing can offset some environmental benefits. But here's the bottom-line: performance matters. If a bio-based additive makes the coating last longer, that extra energy is worth it. In fact, coatings with nanocellulose showed up to 10% longer lifespan, which translates into fewer recoats and less waste.

Bio-based additives: when sustainability meets performance

The coatings industry is under pressure to meet sustainability targets and reduce greenhouse gas emissions. By using simplified LCA tools early in the design phase, manufacturers can make smarter choices, selecting additives that are both functional and eco-friendly.

Plus, this approach aligns with **green chemistry principles**: minimize waste, use renewable resources, and design for energy efficiency. It also supports circular economy goals by using recovered materials like cork and calcium carbonate.

Bio-based coatings aren't perfect yet. Challenges remain, like reducing energy use in biomass processing and ensuring consistent quality. But the trend is clear: **bio-based additives are a powerful lever for sustainability**. Even small changes in formulation can deliver big environmental benefits.

As more data becomes available and processing technologies improve, expect to see bio-based coatings move from niche to mainstream. For now, the message is simple: **don't overlook additives: they might be the key to greener coatings with both reduced environmental impact and enhanced performance**.

Care to help make coatings greener?

At Sirris, we strongly believe that bio-based additives will be a game changer in the coating industry. That's why we actively partner in the COOCK+ AddBIO project, with Centexbel as the coordinator. In this project, biomass suppliers and biomass converters (bio-additive producers) are exploring potential new applications for their products. Based on the intrinsic properties of biomaterials (cellulose, wood, cork, peels, fibers, etc.), these materials offer promising additives for

improving the properties of paints and coatings.

End users are increasingly demanding more bio-based coatings, driven by pressure from their own customers and regulations at various levels of government, driven by the European Green Deal. They are also grappling with how to determine (LCA) and communicate (Product Passport) the ecological impact of the modified product composition they market without risking subsequent accusations of greenwashing.

With the LCA tool described above, we offer the project participants an independent evaluation of coating performance demonstrating environmental impact.

Are you interested in discovering and shaping this new and promising area of greener coatings?

You are very welcome to join the guidance group of the AddBIO project. You can witness first-hand how bio-based additives not only reduce the coatings' carbon footprint but also improve their performance.

Discover the AddBIO project

Interested in the full study?

The complete study is available for free and offers in-depth insights into the research findings and their implications. Download it now and explore the results in detail at your own pace.

Download the full study

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Do not hesitate to get in touch our expert Pieter Samyn, author of this article.

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Authors



Pieter Samyn