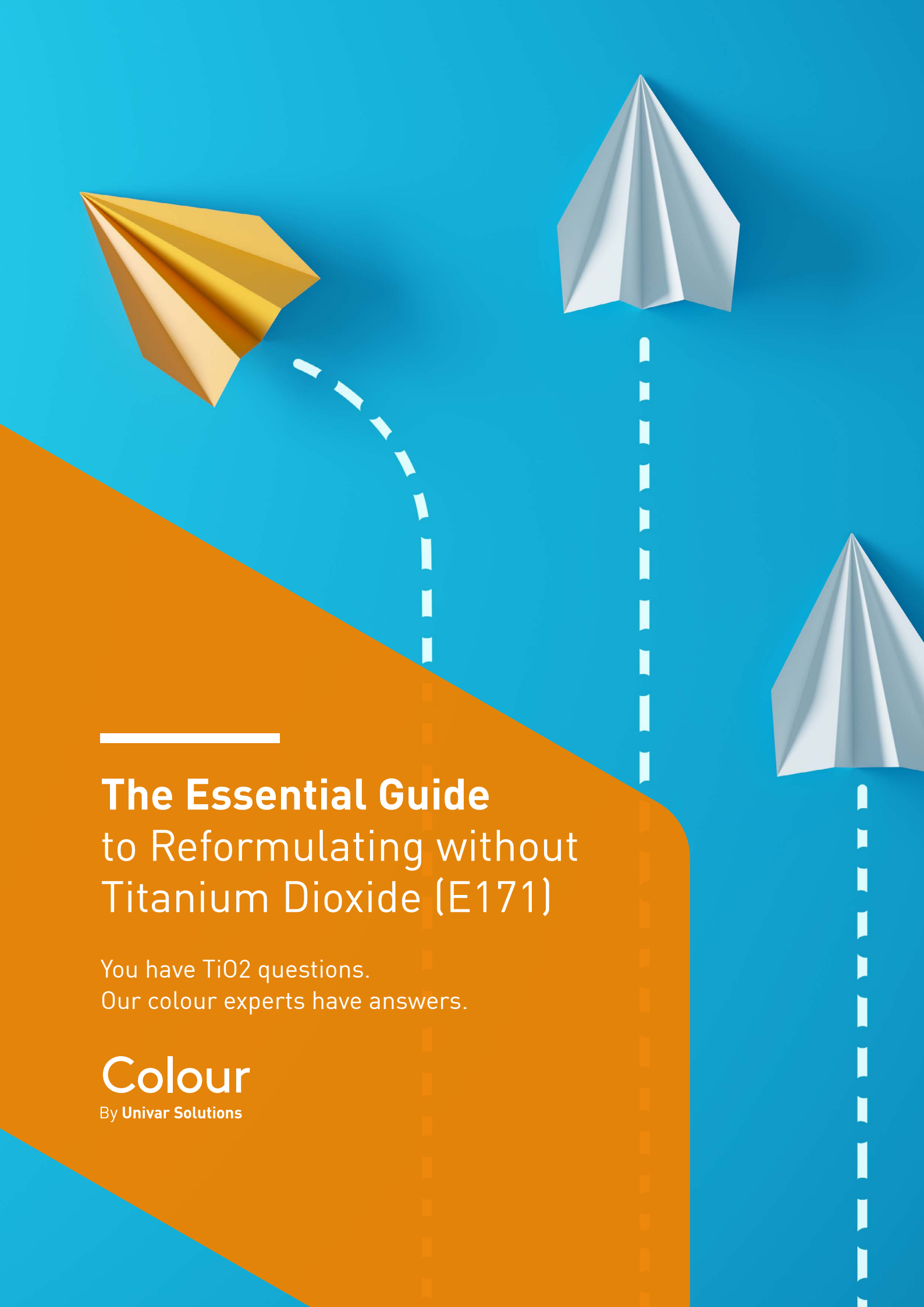

The Essential Guide to Reformulating without Titanium Dioxide (E171)

You have TiO2 questions.
Our colour experts have answers.

Colour
By **Univar Solutions**

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The Essential Guide
to Reformulating without Titanium Dioxide (E171)

Gain critical insight into changing EU Titanium Dioxide (TiO2/E171) regulations and considerations for reformulating with food-grade alternative ingredients

Titanium Dioxide (TiO2/E171) has many valuable properties outside of providing a brilliant white colouration. You could say that it's the unsung hero of the formulation world. This means, and here's the bad news, replacing it isn't easy. There is no one-size-fits-all alternative, and the challenges faced by formulators in a post-TiO2 world are multifaceted.

Our comprehensive guide gets to the heart of the problem. Univar Solutions Colour and Formulation experts answer the technical questions so you are equipped with all the unbiased information you need to know to navigate and select the correct reformulation path.

Who is this guide for? Formulators working in the food, nutraceutical, pharmaceutical, colour cosmetics or personal care industries

This is a 20-30 min read

What you will learn:

- The background to the EU TiO2 changes
- What to consider when formulating without TiO2
- The different options available when reformulating without TiO2
- The unbiased pros and cons associated with reformulating

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Click a question to find out the answer

Your questions

What products and applications are affected by the new statement?

The regulations affect companies and brands using TiO2 in foods, of course, but also in related applications where the ingredient might be ingested. This includes four main industries: food, pharmaceutical, nutraceutical, and beauty and personal care. So while it's clear a wide swath of products in bakery and other food categories are included, products that use TiO2 as a colourant for pills and tablets, toothpastes and gels, lip balms and other ingestible cosmetics, and even face masks, will also need to find a suitable alternative.

Why is TiO2 so difficult to replace in food-grade applications?

The answer lies in the material's broad and wide value across the supply chain. It's economical, versatile and beneficial to product makers and consumers alike. As a food additive and specifically in colour applications, it's hard to overstate the many technical attributes and benefits of E171. A small amount is powerful and efficient, adding not only whiteness, brilliance and sheen, but also enhancing other colours. It makes food look more appealing to consumers, while simultaneously improving texture, stability and shelf life in a vast array of edible or ingested products. And, TiO2 is chemically inert and heat stable under the harshest manufacturing conditions, making it a robust solution that stands up well to pH and temperature fluctuations, and reactions with other ingredients such as flavorings and preservatives.

As a colourant its unparalleled refraction index, or how efficiently light travels through a material, gives TiO2 tremendous whitening and brightening power, helping products look brilliant white but also the perfect shade of pink or other pastel. At the same time its opacity, or hiding power, covers flaws in texture or coverage, helping many products feel smoother or more appealing in the mouth. In food industries where manufacturers and product developers know consumers judge every product on how it looks and feels as well as how it tastes, TiO2 brings a lot to the table.

Why is the application type so important?

When it comes to replacing TiO2 in foods and food-grade applications, not only is success in the details, but failure to consider even seemingly small details can cause product failures. Factors such as product substrate or how the TiO2 is applied to the substrate can result in crucial differences between formulations, even in seemingly similar applications.

> *"Factors such as product substrate or how the TiO2 is applied to the substrate can result in crucial differences between formulations, even in seemingly similar applications."*

For example, say we have half a dozen bakery customers that use TiO2 in a similar baked good. The products might look the same or similar, but each customer applies the colourant in a different way, like spreading, spraying or sprinkling, and each has different heating instructions. Each of these applications would need a different solution because particle size drives the chemistry and can give markedly different outcomes. Substrates also vary widely between applications, and lack of attention to these application-specific details can leave product developers with white tablet coatings that don't adhere properly or blue cupcakes that look good but don't feel or taste good in the mouth.

Is it possible to simply drop in another material in the formulation to replace the TiO2?

Yes, it might be possible in some cases to substitute an approved ingredient to replace the TiO2. But because this one workhorse ingredient checks so many boxes for food formulators, there's no "one-size-fits-all" drop-in replacement that checks all the same boxes across food-grade applications. That said, there are approved food additives that can achieve whiteness, and others that can achieve opacity and other performance attributes.

Why are the approved replacements so limited?

Remember, the replacement must achieve colour and texture, and stand up to temperature fluctuations, pH changes and ingredient reactions that commonly occur during food production and preparation. Calcium carbonate, the most common industry replacement, is good at achieving whiteness, but can fall down in opacity, where it might impart a chalky taste or feel in the mouth, or an inability to interact well with other recipe ingredients causing a bakery item to fall apart in the packaging.

TiO2-free food applications have a high bar to clear: the resulting product needs to be both visually and texturally appealing, two areas that are vitally important for food developers whose success is measured by how food appeals to all the senses.

"A successful food product looks good, tastes good, feels good in the mouth and lasts on the shelf."

So this isn't only a colour problem?

Exactly. Colour quality is an overarching concern for our customers, but TiO2's stability in the face of temperature and pH fluctuations across applications is what makes the ingredient so valuable and therefore so difficult to replace in food-grade applications. Many formulators factor in colour as a last consideration, almost as an afterthought, but because colour additives can affect so many product attributes, we encourage customers to raise the priority of the colour decision. Considering colour much sooner in the decision-making process eliminates common errors in colour quality but also product stability.

Is there a way to achieve colour without affecting product stability? In other words, is there a way to partially reformulate without starting from scratch?

Yes, it might be possible to do this in certain applications. By using a combination of materials to accomplish the benefits of TiO2, a formulator might be able to use an approved colourant like calcium carbonate to achieve the desired colour or pigment and one or two other materials suitable to the application to achieve opacity. Essentially, it might be possible to exclude TiO2 in the formulation with a selection of materials to achieve an acceptable end product. As long as these substitutions don't hinder product stability or other performance attributes, a partial reformulation solution might be attractive in terms of total time and cost to reformulate.

Why isn't this the preferred solution?

Because replacing TiO2's many advantages is a tall technical order. The customer solves one problem (achieving the desired colour) with an approved replacement additive, but in doing so adds another problem or series of problems that cannot be solved without adversely affecting the colour, or the smoothness, or the mouth feel, or the shelf life, any one of which might be an unacceptable compromise. This is where formulators often get stuck. But if the ingredients will not work on their own, or the TiO2 cannot be excluded with a few new materials, then we have to take a more robust approach to solving the problem. Fortunately, there are formulation solutions to the same sets of physical problems.

Does that mean a complete reformulation?

When a partial TiO2 replacement doesn't achieve the formulator's desired results (think too many unacceptable compromises), then it's time to consider a new formulation. From our experience working with colour in food and food-grade applications, we know there is a proper combination of ingredients in proper proportions that will solve the technical problem. When we reformulate with a particular benchmark in mind, we often arrive at a better technical solution.

"And of course, by prioritizing the customer's unique business and operational goals in the process, reformulating allows the solution to be absolutely focused on the customer's specific market demands and business drivers."

Completely reformulating seems too daunting, especially for small and mid-sized companies. What are the downsides to consider?

Compared with a partial reformulation or attempting to drop in a replacement material to achieve colour, a complete reformulation can include higher costs and longer time commitments, especially in the short term.

Won't reformulating require new nutritional testing, relabeling, packaging and other merchandising costs?

No matter how a company decides to formulate away from TiO2, any ingredient change triggers a number of changes in terms of testing, packaging, labeling and marketing. We always remind food customers to first account for compliance and nutritional considerations, because these safety and labeling approvals can certainly be a limiting factor in getting a new formulation change on the shelf. Companies know they will have to accept some costs and changes to remove the E171 in their products. The key is to understand the real costs involved and work to reduce impacts of each option.

You mentioned upfront costs of reformulating. What longer-term advantages should be considered?

By stepping back to solve all aspects of the complex technical problem, the new formulation eliminates the unacceptable compromises, resulting in a better, more sustainable formulation that is completely tailored to the customer's industry, enterprise, business drivers and exact application. Reformulating allows customers to check all of the performance attributes of TiO2, promoting a better, longer-lasting finished product.

Any other considerations?

Starting from scratch can take companies out of their comfort zones, but in addition to creating a more robust, TiO2-free solution, reformulating can also be a valuable opportunity for your enterprise. It's good news that we can formulate this way because ingredients are changing all the time. Investing in a solution-focused methodology offers a tremendous opportunity for formulators to make sure their blends are current and future-proof. With trends and ingredients constantly changing, the best solution for formulators is always the most efficient system possible.

"Starting from scratch can take companies out of their comfort zones, but in addition to creating a more robust, TiO2-free solution, reformulating can also be a valuable opportunity for your enterprise..."

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So a custom solution completely tailored to each company's benchmarks and business drivers can be affordable, even for smaller players?

We understand total cost is one of the big barriers for formulators looking at TiO2 alternatives. But experience has shown us time and time again that retrofitting an outdated or older design can ultimately be more expensive than developing – and benefitting from – newer, more efficient concepts. The same is often true when reformulating away from E171. Formulators should carefully balance the pros and cons of each replacement solution, but reformulating can be a viable and affordable option for manufacturers of any size.

How does the reformulating process work?

Once we determine reformulation is the best path forward, we generally use a three-phased methodology to reformulate away from an ingredient:

1. Prescreen individual materials in the finished application to see if they have a positive or a negative effect, to determine if the material is worth keeping.
2. Take all the materials that work and mix them together in different proportions to see if there's a complementary or a canceling effect.
3. We then move to the formulation stage, trying and testing different inclusion levels and ratios to arrive at the optimum formulation.

The goal in the lab is to use the minimum amount of testing to obtain the maximum amount of rich data, allowing our team to predict results where there is no physical test. Our overriding goal is always to achieve the maximum performance at the lowest cost for the customer, again given customer business drivers and preferences about compromises.

Can you share any real-world application examples?

In the pharmaceutical and nutraceutical industries, TiO2 performs a vital role in the manufacture of vitamin, pill and tablet coatings, making medicines, vitamins and other nutraceuticals easier to swallow and therefore more likely to benefit patients and consumers. So, when a nutraceutical customer approached us about developing a TiO2-free coating, the stakes were high for the customer and potentially the market.

With close customer collaboration, we learned several nuances in the pill coatings niche market that we had to consider, including substrate, material behaviours and manufacturing constraints. For example, formulators in the nutraceutical space often stipulate that they are prepared to accept higher costs, as well as changes to the formulation or manufacturing process, but they will not accept increases in production time. So, with that as the red line, our new formulation was developed to be comparable in production time. Working closely with the formulator, we were able to develop a TiO2-free coating that has achieved outstanding results in color, texture, adhesion and all other performance attributes, without sacrificing production time.

This is a lot to consider. What's the next step?

You've already taken an important first step by learning more about the complex technical challenge at hand. No matter how you decide to move forward to solve the challenge, our global Solution Centers and specialized Colour team can provide the help you need to improve consumer safety and protect your brand without compromising on product quality or process efficiency. Contact our Colour experts to learn more about reformulating to replace titanium dioxide in your product line.

Need a custom solution or alternative for titanium dioxide in your recipe or formula? click here

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https://univarcolour.com/pages/contact-us
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