

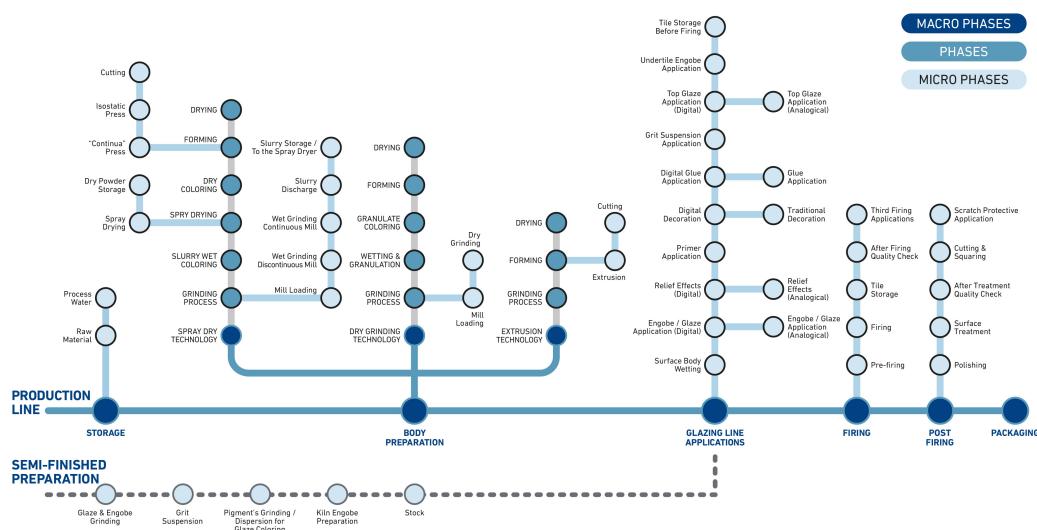


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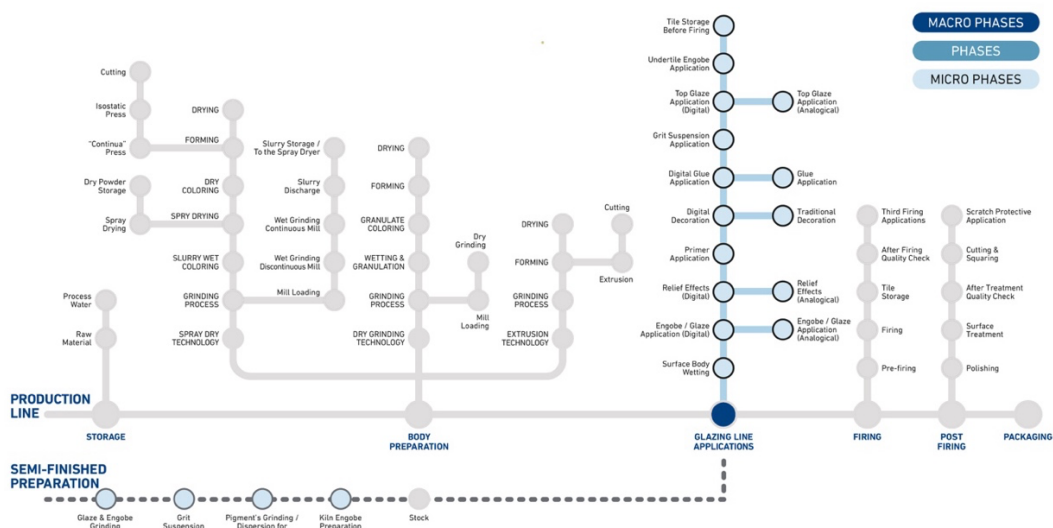
APPARENTLY INVISIBLE YET CONSTANTLY PRESENT

At every stage of the ceramic production process

A journey through problems & solutions



#71 SEMI-FINISHED MEDIA FOR SOLVENT-BASED GLUES, INKS AND DIGITAL EFFECTS





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Introduction

Digital decoration has fundamentally redefined modern ceramic manufacturing. Today, virtually every ceramic tile produced worldwide is decorated using inkjet printing technology — a process that requires inks and materials with tightly controlled chemical and physical properties. To meet these demands, Zschimmer & Schwarz has developed the DECOFLUX DP range: a portfolio of solvent-based semi-finished media designed for the production — either in-house or through specialized suppliers — of glues, inks, and digital effects for ceramic digital decoration.

The context: digital printing in ceramic manufacturing

Inkjet technology has transformed ceramic surface decoration at a structural level. With more than 90% of production lines — effectively the entire industry — now operating digital printing equipment, the ability to formulate high-performance inks has evolved from a competitive advantage into an operational necessity.

Ceramic digital inks are primarily suspensions of inorganic pigments dispersed in a liquid carrier. The solvent selected defines the ink category: solvent-based systems rely on non-polar organic solvents that provide the rheological characteristics and chemical compatibility required for reliable printhead performance. The non-polar nature of these systems is essential, as it enables stable pigment dispersion while ensuring the low surface tension — typically between 28 and 35 mN/m — needed for precise droplet formation.

The DECOFLUX DP range was developed specifically for this environment: a modular technology platform that enables ink manufacturers — from specialized ink producers to ceramic companies developing in-house capabilities — to formulate products optimized for digital printing while maintaining complete process flexibility.

The DECOFLUX DP range: structure and functional design

Overview

Product	Main function
DECOFLUX DP D 282	Universal-use dispersant
DECOFLUX DP S 293	Stabilizing co-dispersant
DECOFLUX DP R 5	Low viscosity modifier
DECOFLUX DP R 12	Medium viscosity modifier
DECOFLUX DP R 24	High viscosity modifier



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The DECOFLUX DP range consists of three functional subsystems designed to work in synergy and support the entire ink manufacturing process, from pigment milling through to final viscosity adjustment before printing.

1. Pigment-Specific Milling Media (DECOFLUX DP – Chromatic Series)

The first subsystem comprises milling media individually optimized for specific ceramic pigments. The product code incorporates the pigment color (e.g. DECOFLUX DP 210 Red Brown, DECOFLUX DP 211 Yellow, DECOFLUX DP 206 Beige), making the relationship between medium and pigment immediately clear and intuitive.

These products function primarily as pigment dispersing media, facilitating efficient milling and concentrate stabilization. They contain a carefully balanced package of **polymeric dispersants and stabilizing additives dissolved in a solvent carrier**, specifically engineered to ensure effective grinding performance and long-term concentrate stability.

Without an efficient dispersing system, pigment particles reduced to submicron dimensions during milling tend to re-agglomerate spontaneously, preventing the dimensions and stability required for digital printing. DECOFLUX media operate at the solid-liquid interface: during milling, dispersing agents adsorb onto the surface of newly generated pigment particles, creating a protective layer that prevents re-agglomeration and preserves suspension stability over time.

Each ceramic pigment has its own crystal structure, morphology, apparent density, and surface chemistry. For this reason, every DECOFLUX chromatic product has been specifically optimized in the laboratory for its target pigment, ensuring maximum performance within that system.

Production is carried out using bead mills. It is important to note that bead mills employed for inkjet ink production are highly specialized pieces of equipment designed for micron-scale particle size reduction and cannot be considered interchangeable with mills used for conventional ceramic materials such as frits or glazes. These systems are available in scalable configurations, ranging from laboratory units to industrial-scale installations with capacities of up to 150 liters.

The milling process produces a highly concentrated pigment dispersion — commonly referred to as a “paste” — with a high solids content. At this stage, however, the product is not yet suitable for printing. The elevated solids-to-liquid ratio generates significant internal friction, resulting in a viscosity far beyond the operating range required by inkjet printheads.

Ink production therefore consists of two distinct stages. The first is pigment milling in the DECOFLUX medium to obtain a stable concentrate. The second is dilution of that concentrate using viscosity modifiers from the DP R series until the rheological properties required for printing are achieved. As DP R solvent is introduced, pigment particles become progressively separated and viscosity gradually



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decreases, bringing the system into the printhead's operating window. Only after this second stage is completed does the formulation become a finished ink ready for machine loading.

2. Viscosity modifiers (DECOFLUX DPR5, DPR12, DPR24)

Once the concentrate is reached, it must be diluted to the optimal viscosity for printing — a critical parameter for proper inkjet printhead function. To this end, the DECOFLUX range includes three **viscosity modifiers**: DP R 5, DP R 12, and DP R 24.

All three products are fully compatible with the chromatic milling media and mutually miscible in any proportion. They differ by increasing viscosity: DP R 5 is least viscous, DP R 24 most viscous. This gradient allows the formulator to modulate finished ink viscosity with precision, leveraging two simultaneous variables: concentrate dilution and selection or blending of the most appropriate modifier.

Selection of the correct DP R depends on system-specific variables: pigment density (pigments with heavy atoms exhibit higher apparent density — thus, for example, 100 g of yellow occupies less volume than 100 g of brown spinel), desired solids percentage in the finished ink, and the target viscosity required by the printhead.

No universal choice exists: each decision must be carefully calibrated according to the specific quality target and production context. A high-pigment-load ink will require a lower-viscosity DP R to compensate; a more dilute system may instead benefit from DP R 24. Proper case-by-case evaluation ensures optimal balance between performance and process characteristics.

Beyond rheological regulation, DECOFLUX DP R modifiers enhance ink lubricity and offer protection against drying even at elevated temperature — relevant for product stability on high-throughput printing lines.

From an operational perspective, DECOFLUX DP R products require no special handling precautions: they are liquids with negligible odor in production environments, water-insoluble (as expected for nonpolar systems intended for solvent environments), and carry no hazard labeling symbols. These properties make them ideal for production-line use without adversely affecting operator conditions.

3. Primary dispersant and co-dispersant (DECOFLUX DP D 282 e DP S 293)

The third subsystem comprises two products serving **purely dispersing function**, designed for custom formulation or stabilization of products beyond standard pigments.



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DECOFLUX DP D 282 is a universal primary dispersant: unlike chromatic-series media — which are complete formulations each optimized for a specific pigment — DP D 282 **is a concentrated active component**. This makes it the ideal starting point for those developing novel milling processes for charges / products outside the chromatic series: non-standard pigments, ceramic frits, micronized raw materials, glazes, lusters, and any other inorganic charge requiring digital printhead applicability.

DECOFLUX DP S 293 acts as a co-dispersant, or secondary stabilizing agent. Used alongside DP D 282 at the recommended dosage levels, it further enhances the stability of the dispersed system. Its action complements that of the primary dispersant: by competing for adsorption sites on the particle surface, it helps maintain a soft, easily re-dispersible sediment while improving the long-term stability of both the concentrate and the finished ink.

When properly formulated, inks produced with the DECOFLUX range have shown stability for more than ten months, both in concentrated form and in their diluted, press-ready version.

Main features

Product	Solubility	Density (a 20°C)	Viscosity (a 25°C)
DECOFLUX DP D 282	Non solubile in acqua	~ 0.91 g/cm ³	~2000 mPas
DECOFLUX DP S 293	Non solubile in acqua	~ 0.94 g/cm ³	~1200 mPas
DECOFLUX DP R 5	Non solubile in acqua	~ 0.85 g/cm ³	< 8 mPas
DECOFLUX DP R 12	Non solubile in acqua	~ 0.85 g/cm ³	< 15 mPas
DECOFLUX DP R 24	Non solubile in acqua	~ 0.85 g/cm ³	< 28 mPas

Formulation strategy: a five-component modular system

The strength of the DECOFLUX range becomes particularly evident when looking at the overall formulation philosophy behind it. The five products that make up the universal subsystem — DP D 282, DP S 293, DP R 5, DP R 12 and DP R 24 — form a complete, self-contained toolkit for developing virtually any solvent-based ink or medium, regardless of the type of pigment or solid phase being processed.

The workflow is straightforward. DP D 282 serves as the primary dispersant and is selected according to the chosen pigment. DP S 293 is then incorporated to further enhance system stability. Milling is carried out at the most suitable solid-to-liquid ratio, optimised during laboratory testing. Once the concentrate has been produced, it is adjusted to the required jetting viscosity using one or more of the viscosity modifiers DP R 5, DP R 12 and DP R 24, blended in the proportions needed to achieve the desired rheological profile.

Because every component has been designed to work seamlessly with the others, the system is fully compatible and interchangeable. No additional deflocculants, separate suspension agents or auxiliary additives are required. In practice, the formulation can be reduced to its essential building blocks: pigment, dispersant, co-dispersant and viscosity modifiers.



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Where a dedicated color-series medium is already available for a specific pigment, the process becomes even more streamlined. In this case, the color-specific DECOFLUX medium replaces the DP D 282 + DP S 293 combination, as the product has already been tailored and optimized for that pigment chemistry.

This significantly reduces laboratory development work. Much of the formulation effort has already been carried out by the Z&S technical team, providing customers with a validated starting point from which only application-specific dosage adjustments may be required.

The choice between the two approaches — a pre-optimized color medium or the universal DP D + DP S + DP R platform — ultimately depends on the user's objectives. The former prioritizes rapid implementation, consistency and ease of use; the latter offers maximum formulation freedom, making it particularly suitable for non-standard applications or for manufacturers seeking to develop and retain proprietary know-how around their own ink formulations.

Applications: extending far beyond ceramic pigments

One of the key technical strengths of the DECOFLUX DP range lies in the breadth of materials it can accommodate. The dispersants and co-dispersants have been developed and validated not only for ceramic color pigments, but also for a wide variety of inorganic solids with different chemical and physical characteristics.

Ceramic frits, micronized raw materials, mineral fillers for digital glues, glazes and lusters can all be milled and stabilized within a non-polar organic solvent system using DECOFLUX components. In principle, any inorganic material that can be ground to particle sizes compatible with inkjet technology and dispersed in a solvent carrier can be considered a suitable candidate for formulation with DECOFLUX.

This versatility is the result of years of development work extending well beyond conventional ceramic pigments, supported by practical validation on frits and raw materials under real production conditions.

The same approach applies to so-called *effect inks* and digital materials used in ceramic decoration. Products such as sinking agents, digital glazes and lusters are not coloring inks in the strict sense, yet they are deposited through the same inkjet technology and face many of the same formulation challenges. DECOFLUX media can be used to formulate and stabilize these systems just as effectively. For this reason, the DECOFLUX range is not limited to the production of the company's True Color inks. Its scope extends to virtually any solvent-based material designed for digital application, providing a versatile formulation platform for a broad spectrum of inkjet-decorated ceramic products.



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Technical support and process optimization

Successful implementation of the DECOFLUX platform requires a degree of laboratory optimization to fine-tune the formulation. The extent of this work depends on the approach adopted: relatively limited when starting from a pre-optimized color-specific medium, and more comprehensive when developing formulations using the universal DECOFLUX components.

Key parameters to be refined include dispersant dosage relative to the solid phase, which is influenced by the particle's specific surface area and chemical nature, as well as milling conditions, concentrate viscosity and the final dilution profile required for application.

Throughout this process, Zschimmer & Schwarz works closely with customers, providing formulation guidelines, recommended starting points and technical support during development and scale-up. The objective is not simply to supply a one-size-fits-all ready-to-use product, but to help customers establish a stable, robust and fully reproducible process tailored to their specific combination of raw materials, production equipment and application requirements.

Positioning within the value chain: who is DECOFLUX designed for?

The DECOFLUX DP range is primarily intended for ink manufacturers specializing in ceramic digital printing. For these operators, it provides a reliable chemical platform on which to build their own product portfolio, backed by a supplier with decades of experience in ceramic chemistry and formulation technology.

A second target group consists of ceramic manufacturers that choose to produce their own inks or digital products in-house. While this approach is less common than purchasing finished inks, a modular platform such as DECOFLUX makes the development of proprietary formulations technically achievable for these users as well.

In both cases, DECOFLUX products fit naturally within the broader Zschimmer & Schwarz technology portfolio, which also includes TRUCOLOR finished inks – formulated using the same media – as well as other products for the ceramic digital printing process, such as glues, levelling agents and printhead cleaners.

This system-wide consistency represents a valuable advantage for customers looking to develop in-house formulation expertise, supported by a technical partner capable of providing guidance across the entire digital decoration process.

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