From Pixels to Performance: Advancing Coatings with Dow's Integrated Research Imaging Solution

Introduction

The coatings industry is undergoing a profound shift, driven by the accelerating pace of digital transformation. As materials science industries strive to improve product performance, reduce development cycles, and enhance sustainability, digital tools are becoming essential to modern R&D. Dow is at the forefront of this evolution by incorporating advanced technologies—such as artificial intelligence, machine learning, and computer vision—into its innovation pipeline.

One of the key initiatives within this transformation is the Integrated Research Imaging Solution: a system that combines advanced imaging hardware with proprietary Artificial Intelligence (AI) driven algorithms to evaluate coating performance, as shown in Figure 1. Traditionally, coatings have been assessed through visual inspection—a technique that often introduces subjectivity into ratings and is difficult to scale. Dow's solution addresses this challenge by translating the "look and feel" of a coating into quantitative, reproducible metrics, supporting more reliable performance testing and faster product development.

Standardized hardware allows **accurate and reliable image capturing** for defect analysis

AI-based computer vision algorithms provide **robust quantitative assessment** of performance

Figure 1. Overview of Integrated Research Imaging Solution hardware and software.

Computer vision, a subset of artificial intelligence suited for analyzing image data, is particularly well-suited to this task. Images are among the most intuitive and widely used formats for presenting and interpreting data. By applying AI-driven analysis to standardized images of coated surfaces, the Integrated Research Imaging Solution can measure color differences, visualize texture, and identify defects with scientific precision. This approach not only unveils new insights but also supports the broader goal of data-driven decision-making in the lab.

As we explore in the sections ahead, the success of this innovation hinges on more than just capturing high-quality images—it requires rigorous standardization, best practices for preserving image context, and AI-driven algorithms that mimic physics and experience of the researchers.

From Concept to Deployment

Dow's Integrated Research Imaging Solution was developed to address a fundamental challenge in coatings R&D. Visual performance assessments were inconsistent, subjective, and difficult to scale. Manual evaluations of color, texture, and defects varied across individuals and labs, limiting reproducibility—especially as Dow's global R&D footprint expanded, and digital transformation became a strategic priority.

To address this challenge, a critical first step was ensuring that images captured during coatings tests accurately represented the features of interest. Integrated Research Imaging Solution helps enable researchers to develop application-specific imaging configurations that standardize image capture by adjusting parameters like camera height, lighting, and imaging mode to highlight specific coating features. Each image is tagged with metadata and captured under controlled conditions, ensuring traceable, context-aware analysis. This consistency enabled the development of over 20 proprietary image analysis algorithms—created in collaboration with subject matter specialists—to quantify surface defects, color variation, and texture with high precision. The system also allows user input to refine measurements, enhancing objectivity and reproducibility. By integrating imaging and analytics into a unified workflow, Dow significantly reduced variability and improved decision-making in coatings assessments.

Today, 12 units are deployed across Dow's global R&D sites, ensuring consistent image capture and analysis regardless of location. This standardization has enhanced collaboration, accelerated product development, and transformed how visual performance data is generated and shared.

Real-world Impact: Case Studies in Innovation

The following case studies highlight how Dow has successfully applied the Integrated Research Imaging Solution to transform traditionally qualitative, subjective assessments into quantitative, data-driven metrics. By leveraging computer vision and tailored image analysis algorithms, these examples demonstrate how Integrated Research Imaging Solution supports faster, more consistent, and more objective coatings evaluation—ultimately driving product innovation across diverse application areas.

Spatter Resistant Additives

In the development of spatter-resistant architectural coatings, evaluators often rely on visual inspection to judge how densely droplets are scattered and how large the droplets appear on application panels—an approach that is inherently subjective and time-consuming. Through Integrated Research Imaging Solution, Dow developed image analysis algorithms that extract physical parameters such as droplet size, dispersion density, and distribution patterns from spatter test panel images. The metrics powered a machine learning model that replicated expert ratings with improved accuracy and efficiency. By replacing manual assessments, the automated model not only accelerated formulation screening but also revealed performance trends with greater clarity—for instance, it identified ICI Builder 4 and ICI Builder 2 as the highest and lowest performers respectively, in agreement with expert evaluations, as shown in Figure 2. Within this experimental series, Dow's ACRYSOL™ RM-3030 Rheology Modifier demonstrated the best overall spatter resistance performance. Using Integrated Research Imaging Solution, the researchers also confirmed that the inclusion of hydroxyethyl cellulose (HEC) as a co-thickener consistently reduced spatter resistance, offering actionable insights for formulation enhancement—an impact highlighted in the Coatings Tech January–February 2025 issue.

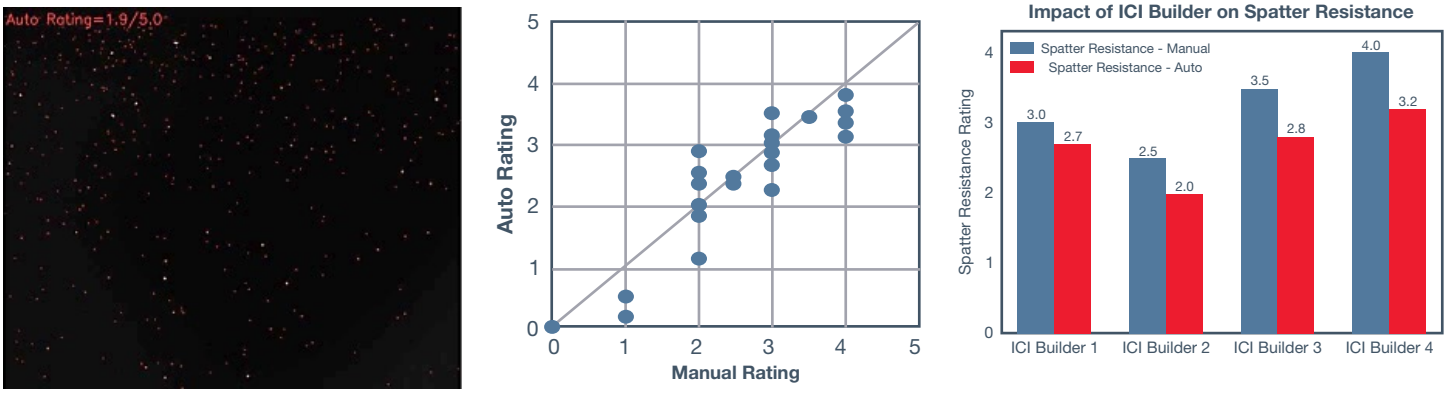

Figure 2. Regression model results in spatter resistance panel by measuring spatter pattern features on an imaged panel.

Waterborne Coatings for Paper

In developing waterborne coatings with the absence of intentionally-added per- and polyfluoroalkyl substances (PFAS) for paper, Dow researchers followed ASTM methods to evaluate grease resistance by measuring the extent of grease breakthrough. Traditionally, this process involved manually identifying and quantifying affected areas—a time-consuming and inconsistent task, especially when breakthrough patterns were irregular or faint. Using the Integrated Research Imaging Solution, Dow implemented standardized imaging conditions that clearly distinguished breakthrough regions from the paper background, helping enable more accurate and consistent identification. Deep learning models were then applied to classify breakthroughs from the background to quantify the area. Capable of analyzing nine replicates at once, the system accelerates testing and drives greater R&D efficiency. These advancements have been instrumental in supporting the development of RHOBARR™ Barrier Coatings, Dow's waterborne platform designed to offer high-performance barrier options without added PFAS substances for paper packaging applications.

Oil-Grease Resistance (OGR)

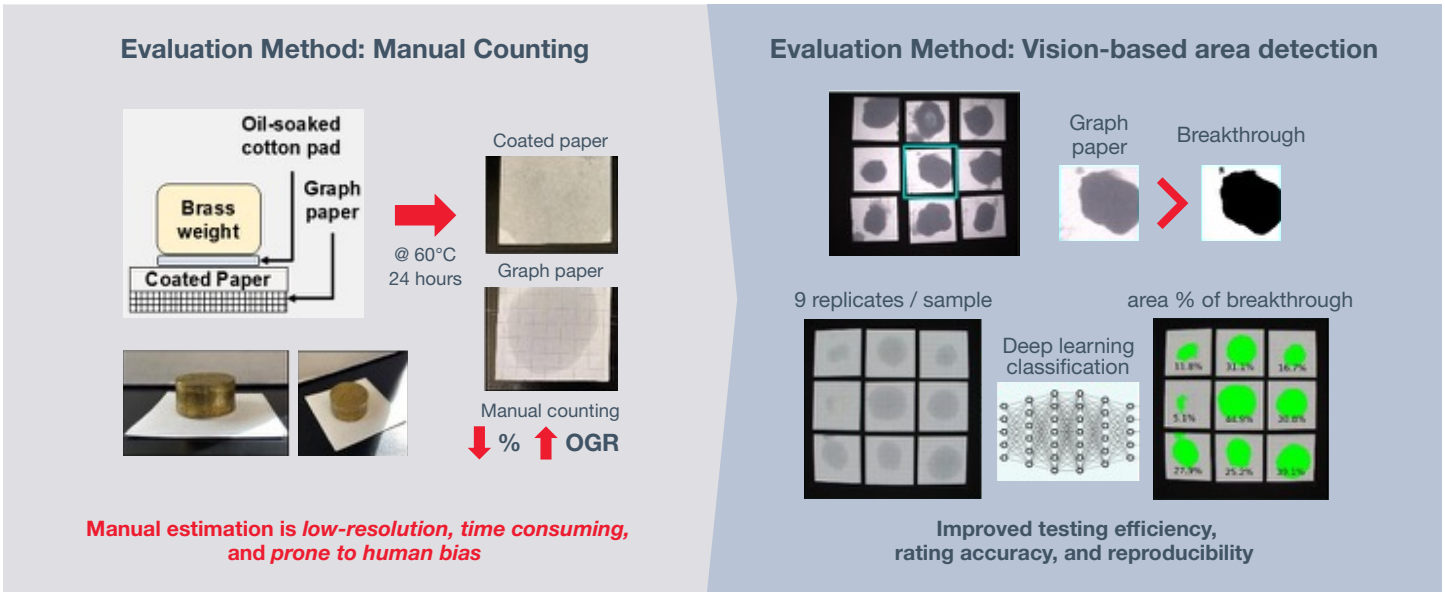

Figure 3. Analysis method comparison for area quantification in paper coatings.

Stain Resistance Test Measurement

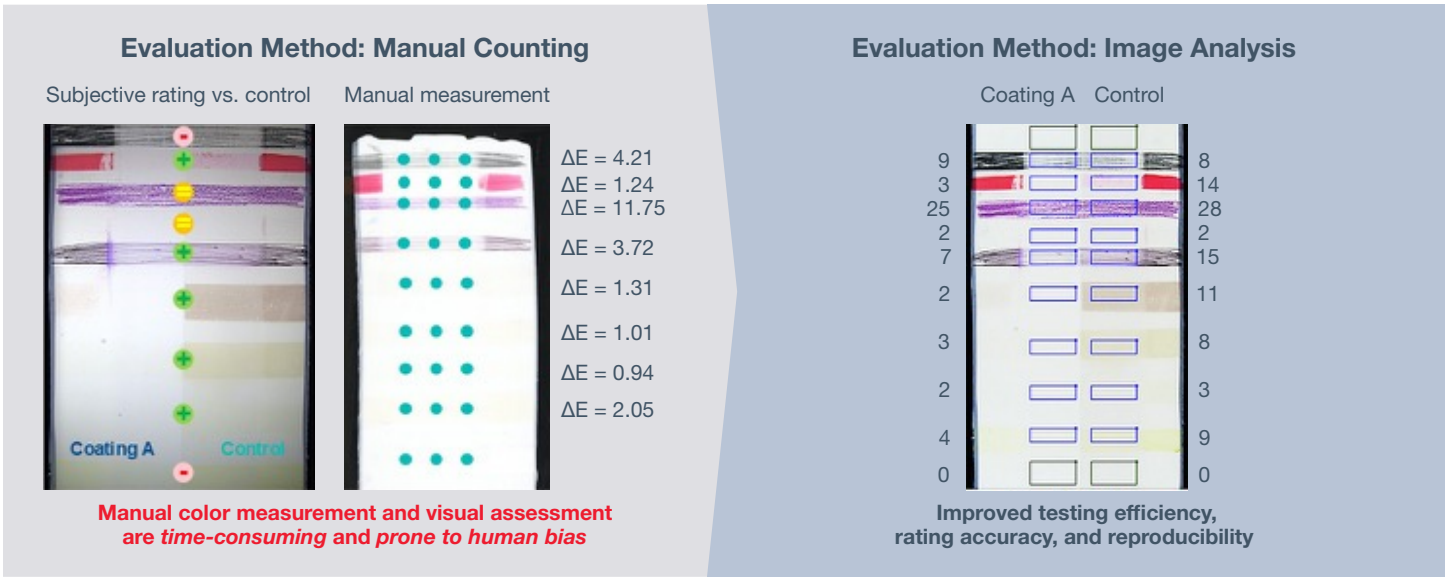

Figure 4. Analysis method comparison of color difference measurement in stain resistance testing.

Summary and Strategic Opportunities

While AI and computer vision are gaining traction across industries, their application in coatings R&D remains limited—particularly in visual performance testing, where subjective evaluations still dominate. Dow's Integrated Research Imaging Solution addresses this gap by transforming subjective and visual assessments into quantitative, reproducible data through standardized imaging workflows and tailored algorithms. With 12 systems deployed across global R&D sites, Integrated Research Imaging Solution has already demonstrated its ability to offer consistent results, accelerate product development, and enhance collaboration across researchers with varying levels of technical experience.

Looking ahead, Dow envisions expanding Integrated Research Imaging Solution beyond R&D into real-time, in-line quality monitoring during manufacturing. Integrated with machine learning models, Integrated Research Imaging Solution can provide predictive analytics to identify potential performance issues before they occur—shifting quality control from reactive to proactive. As data infrastructure evolves, the imaging solution also opens the door to centralized, global data sharing, allowing researchers to compare results across regions and accelerate innovation without duplicating effort. More than a technological advancement, Dow's Integrated Research Imaging Solution represents a shift in how coatings are developed, tested, and validated-redefining the future of coatings R&D with a smarter, faster, and more connected approach.

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