

A CHINACOAT CONFERENCE

中国国际涂料展指定学术会议

3-4.12.2018 ● 广州香格里拉大酒店礼堂演播厅
Auditorium, Shangri-La Hotel, Guangzhou

绿色涂料 前沿技术与新材料

Green Coatings — Advanced Technology & New Materials



| 会议主席
Conference Chairman

Prof. Jamil Baghdachi 教授
美国东密歇根大学
Eastern Michigan University, USA



会议主办单位 Conference Organisers

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会议日程一览 CONFERENCE PROGRAMME AT-A-GLANCE

3.12.2018 (星期一 Monday)

A CHINACOAT CONFERENCE
中国国际涂料展指定学术会议

08:45 - 09:15	与会者登记 Registration
09:15 - 09:45	开幕演讲 OPENING SPEECH 聚焦绿色涂料前沿技术与新材料 Green Coatings — Advanced Technology and New Materials
第一 节 SESSION I	
09:45 - 10:25	主题论文 KEYNOTE PAPER 1 用于木器的超低温可固化粉末涂料： 低于水沸点的无 VOC 技术 Ultra-Low Temperature Curable Powder Coatings for Wood: VOC-Free Technology Below the Boiling Point of Water
10:25 - 11:05	论文 PAPER 2 塑胶漆用水性丙烯酸树脂的开发与应用 Development and Application of Waterborne Acrylic Resin for Plastic Paint
11:05 - 11:45	论文 PAPER 3 用于涂料的高性能聚合物粉末 High Performance Polymer Powders for Coatings
11:45 - 12:25	论文 PAPER 4 专注于新应用和高功效的低温固化粉末涂料系统 Low Temperatures Curing Powder Coatings System for New Applications and Robust Process Efficiency
12:25 - 13:35	午餐 LUNCH
第二 节 SESSION II	
13:35 - 14:15	论文 PAPER 5 不可或缺的表面助剂的功效 VS 化学 Indispensable Surface Additives Effect VS Chemistry
14:15 - 14:55	论文 PAPER 6 新型光稳定剂应用于水性光固化涂料 UV 阻隔效应 Novel Light Stabilizer Enhances the UV-Filtering Ability of Waterborne UV-Curable Coatings without Sacrifice on Curing Speed
14:55 - 15:10	茶歇 COFFEE BREAK
15:10 - 15:50	论文 PAPER 7 PU 改性醇酸乳液的传统和新型应用领域 Classical and New Application Fields for PU Modified Alkyd Emulsions
15:50 - 16:30	论文 PAPER 8 低 VOC、2K 水性 PU 防涂鸦涂料发展 Development of Low VOC 2K Waterborne PU Anti-Graffiti Coatings
16:30 - 16:45	讨论环节 Discussion Session
16:45	第一天完 End of Day 1
17:00	会议结束 End of Conference



4.12.2018 (星期二 Tuesday)

12:30 - 13:00 与会者登记 Registration

第三 节 SESSION III

13:00 - 13:40	主题论文 KEYNOTE PAPER 9 水下自愈合聚合物 Underwater Self-Healing Polymer
13:40 - 14:20	论文 PAPER 10 防污长效抗菌阳离子聚氨酯分散体涂层 Synthesis and Characterization of Anti-Smudge and Long-Lasting Anti-Bacterial Cationic Polyurethane Dispersion
14:20 - 15:00	论文 PAPER 11 具有出色建筑和工业涂料性能的生物基醇酸乳液 Biobased Alkyd Emulsion with Outstanding Performances for Architectural and Industrial Coatings
15:00 - 15:15	茶歇 COFFEE BREAK
15:15 - 15:55	论文 PAPER 12 应用于工业涂料及建筑材料体系的新一代流变剂 Next Generation of Thickeners in Industrial Coatings & Construction Systems
15:55 - 16:35	论文 PAPER 13 雨水对水性紫外光安定剂的影响 The Effect of Rainfall on Waterborne UV Stabilizers
16:35 - 16:50	讨论环节 Discussion Session
16:50 - 17:00	闭幕辞 Closing Remarks
17:00	会议结束 End of Conference

* 论文演讲和讨论将以英语和普通话进行。All presentation of papers & discussion will be conducted in both English & Chinese (Putonghua).

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第一节 SESSION I

3.12.2018 (星期一 Monday) • 09:45 – 12:25

Prof. Rolf Van Bentheim
教授

公司科学会员
Corporate Science Fellow
帝斯曼, 荷兰
DSM, The Netherlands
荷兰埃因霍温科技大学
Eindhoven University of Technology, The Netherlands

用于木器的超低温可固化粉末涂料：低于水沸点的无 VOC 技术

Ultra-Low Temperature Curable Powder Coatings for Wood: VOC-Free Technology Below the Boiling Point of Water

主题论文 KEY NOTE PAPER 1

从生命周期评估研究中对溶剂型和水性涂料技术的比较可看出，粉末涂料在所有涂料技术中每涂层（平方米）的碳足迹为最低。粉末涂料传统应用在金属表面上，将固化温度降低到130°C以下，可将环保粉末涂料技术应用于热敏基材，如MDF、塑料和实木等。本文论描述所谓「粉末涂料范式三角」的基本挑战，就是要达到良好性能的低固化温度同时保持贮存稳定性和良好流动性；此外本文亦展示树脂/交联剂体系的半结晶性与过氧化物引发相结合如何能应对这些挑战，而采用具有完全无定形体系的传统方法却失败。这与动态机械分析数据证明，与传统完全无定形粉末涂料树脂相比，可定量地观察半结晶粉末涂料树脂的流动和固化行为，这种技术扩展为所有类型的实木和其他高热敏基材上的粉末涂料创造了未来机会。

Powder coatings have the lowest carbon footprint per coated m² of all coating technologies, as is apparent from a Life Cycle Assessment study comparison with solventborne and waterborne coating technologies. Whereas the traditional applications of powder coatings are on metal surfaces, a lowering of the curing temperature to below 130°C enables the application of eco-friendly powder coating technology on heat sensitive substrates such as MDF, plastics and solid wood as well. In this presentation I will describe the fundamental challenges that have to be met in order to reach such low curing temperatures with good properties, while retaining storage stability and a good flowability, in the so-called "powder coating paradigm triangle". I will demonstrate how semi-crystallinity of the resin/crosslinker system, in combination with peroxide initiation, is able to meet these challenges, while traditional approaches with fully amorphous systems fail. This is evidenced with Dynamic Mechanical Analysis data, visualizing flow and cure behaviour quantitatively of semicrystalline powder coating resins, as compared to the traditionally fully amorphous powder coating resins. This technology extension creates future opportunities for powder coatings on all types of solid wood and other highly heat sensitive substrates.

申亮教授
Prof. Liang Shen

江西科技师范大学化学化工学院，
南昌，中国
Jiangxi Science & Technology
Normal University, Nanchang,
China

塑胶漆用水性丙烯酸树脂的开发与应用

Development and Application of Waterborne Acrylic Resin for Plastic Paint

论文 PAPER 2

介绍了塑胶涂料的市场概况，研究了丙烯酸乳胶和水性UV树脂在单组份水性塑胶漆中的应用，羟基丙烯酸分散体在双组分塑胶漆中的应用。针对塑胶基材的特点，进行了树脂的分子设计和表面改性，给出了一系列的水性塑胶漆应用案例，提出了水性丙烯酸塑胶漆的发展方向。

This paper introduces the general situation of the market of plastic coatings, and studies the application of acrylic latex and waterborne UV-curable resin in single-component waterborne plastic coatings, and the application of hydroxyl acrylic dispersion in two-component plastic coatings. In view of the characteristics of plastic base material, the molecular design and surface modification of the resins were carried out, and a series of application cases of water-based plastic paint were listed. Then the development direction of waterborne acrylic plastic paint was been pointed out.

Dr. Frank Schubert 博士
粉末产品新业务开发经理
Manager New Business,
Development Powders
赢创资源效率有限公司，德国
Evonik Resource Efficiency
GmbH, Germany

用于涂料的高性能聚合物粉末

High Performance Polymer Powders for Coatings

论文 PAPER 3

本文论重点介绍基于长链聚酰胺和聚醚酮（PEEK）的高性能聚合物粉末在各种涂料应用，例如：金属保护和摩擦涂料。长链聚酰胺提供有价值的物理、化学和电学性质，即使在低温下也具有高韧性及优异的耐化学性，因此非常适合金属保护。PEEK粉末特别适用于极端机械、热和化学要求的涂料应用。涂层材料能承受高达250°C的永久工作温度，其特点是具有抗磨损和化学品的独特能力。此外本文亦介绍用于具有更高温度要求的聚酰胺粉末应用及基于激光涂层技术的最新发展，本文目的是说明长链聚酰胺和PEEK如何在涂料工业中开辟新机会。

The presentation will focus on the use of high performance polymer powders based on long-chain polyamides and polyether ether ketone (PEEK) for various coating applications, e.g. metal protection and tribological coatings. Long-chain polyamides offer valuable physical, chemical and electrical properties. High toughness even at low temperatures as well as excellent chemical resistance making it perfect for metal protection. PEEK powders are particularly suitable for coating applications that are subject to extreme mechanical, thermal and chemical requirements. The coating material is able to withstand permanent operating temperatures of up to 250°C and is characterized by its unique ability to resist abrasion and chemicals. Recent developments on the polyamide powders for applications with higher temperature requirements as well as on laser-based coating technologies will be introduced. Aim of the presentation is to illustrate how long-chain polyamides and PEEK can open new opportunities in the coating industry.

熊荣先生
Mr. Rong Xiong
技术服务与开发经理
TS&D Manager
湛新树脂，德国
Allnex, Germany

专注于新应用和高功效的低温固化粉末涂料系统

Low Temperatures Curing Powder Coatings System for New Applications and Robust Process Efficiency

论文 PAPER 4

低温固化粉末涂料产生较少二氧化碳，所以比普通涂料有更多好处。低温固化粉末涂料需要基料既具有反应活性又具有良好的贮存稳定性。基于该技术的基料可在低至130°C的金属峰值温度下固化10分钟，同时提供优异的涂层性能；此外，它们还可通过红外线固化，成为绿色环保涂料。

Low temperature curing powder coatings are more advantageous than ordinary coatings due to smaller carbon dioxide foot print. Low temperature curing powder coatings require binder technology that both be reactive and have good storage stability. The binders based on these technologies can be cured at peak metal temperatures as low as 130°C for 10 minutes while providing excellent coating properties. Additionally, they can also be cured with infrared, making them even greener.

第二节 SESSION II

3.12.2018 (星期一 Monday) • 13:35 – 16:45

论文 PAPER 5



Dr. Majdi Al-Masri 博士

研发主管

Head of Research Surface
BYK Chemie GmbH,
Germany 德国

范雷平先生

Mr. Leiping Fan

研发经理 - 大中华区
Head of R&D TPT & Surface TG
毕克助剂 (上海) 有限公司, 中国
BYK (Shanghai) Co., Ltd., China

不可或缺的表面助剂的功效 VS 化学 Indispensable Surface Additives Effect VS Chemistry

自涂料工业化以来，业界已进行了大量努力改善涂膜性能，以满足日益增加的复杂应用的需求。助剂被发现是解决特定应用涂料的最简单方法，助剂制造商建立并承担了开发和生产林林总总的添加剂的任务，经历很长的路程。本论文将介绍表面助剂开发的一些亮点。同时还将说明表面助剂的开发阶段，解释它们与化学相关的行为，并对目前一些研究成果提出新的看法，对未来发展和挑战进行阐述。

Since the beginning of industrialization of coatings, intensive efforts have been made to improve film performance in order to fulfill growing requirements with regard to increasing application complexity. Additives were found to be the easiest way to customize coatings for their particular applications. Additive companies were founded and took over the job of developing and producing these additives. They have meanwhile come a long way. The highlight of the surface additive development will be presented. The paper will also illustrate the stages of the surface additive development and provide an explanation for their behavior in relation to their chemistry. New light will be shed on some current research results and an overview of future developments and challenges will be given.

论文 PAPER 6



杨永吉先生

Mr. Yung-Chi Yang

技术经理 Technical Manager
台湾永光化学工业股份有限公司,
台北, 台湾地区
Everlight Chemical Industrial
Corp., Taipei, Taiwan Region

新型光稳定剂应用于水性光固化涂料 UV 阻隔效应

Novel Light Stabilizer Enhances the UV-Filtering Ability of Waterborne UV-Curable Coatings without Sacrifice on Curing Speed

水性光固化涂料因可解决一般传统光固化涂料具有大量挥发性有机化合物 (VOC) 的问题，又兼顾具光固化涂料的优点如快速干燥速率，因而成为近年来环保涂料产品的重点发展项目，而环保型水性光固化涂料所遭遇的挑战有两方面，一方面是暴露在自然太阳光下容易造成外观颜色的变化及涂层劣化、粉化；另一方面，由于水性光固化涂料多用于物体最外层的保护清漆，因此在完成光固化后需具备有良好的 UV 阻隔能力，以维持耐候保护效果。

本实验为针对水性光固化涂料开发一种全新复配型光稳定剂 NLS，以应用实验设计 (DOE) 手法进行实验。一般通用型光稳定剂通常会干扰光固化的速度，但根据本实验结果显示：NLS 不仅不会影响光固化速度、更具有优异的紫外光阻隔能力。

Waterborne Ultraviolet (UV) curable coatings have been developed to replace conventional UV-curable coatings with higher VOC content. Due to fast-drying and short processing time, UV-curable coatings are widely used in various industries. However, there are TWO major challenges - the first one is discoloration after long-term exposure to sunlight; the other one is to keep the ability of UV filtering ability since waterborne UV-curable coatings are usually applied to the surface as a protective top coat.

The novel light stabilizer (NLS) is developed specifically for waterborne UV-curable coatings. Design of Experiment (DOE) was used in the study. Test data showed that the designed NLS would not interfere the curing speed of the tested clear waterborne UV-curable coating system. Moreover the results confirmed that by increasing the concentration of NLS could enhance the UV filtering ability and weatherability of the tested clear topcoat more effectively than by increasing the coating thickness.

论文 PAPER 7



Ms. Caroline Matthiesen

女士

经理 Manager
Worlée 化学责任有限公司, 德国
Worlée-Chemie GmbH,
Germany

PU 改性醇酸乳液的传统和新型应用领域

Classical and New Application Fields for PU Modified Alkyd Emulsions

过去十年，聚氨酯改性醇酸树脂乳液从溶剂型醇酸树脂体系向具有可比较甚至更好性能的水基体系变化做出了重大贡献。虽然 Worlée 无表面活性剂乳液主要作为高光泽装饰、工业和建筑维护涂料中的唯一基料，但它仍有很多应用可能性，使用混合系统也可达到均衡的属性配置；此外，有一种趋势是使用这种内部乳化醇酸树脂乳液作为丙烯酸体系中的添加剂基料，以实现诸如改善应用性能和避免成膜剂以降低 VOC 水平。最新的发展是我们的技术还可产生真正的水性触变性树脂。两个产品，柔软和强力凝胶，可实现多功能性。

In the last decade polyurethane modified alkyd emulsions made an important contribution for the change from solvent based alkyd systems to water based systems with comparable or even better performance. Although Worlée's surfactant free emulsions are mainly used as sole binder in high gloss decorative, industrial and architectural maintenance paints there are diverse application possibilities. Well-balanced property profiles can also be reached with hybrid systems. Furthermore, there is a trend to use this internally emulsified alkyd emulsions as an additive binder in acrylic systems to achieve effects like improved application performance and avoidance of film forming agents to reduce the VOC level. The latest development is that our technology can also lead to real waterborne thixotropic resins. Two products, a soft and a strong gel, enable versatility.

论文 PAPER 8



余美娟女士

Ms. Maggie Yu

实验室经理 Lab Manager
康睿 (上海), 中国
Vencorex (Shanghai), China

低 VOC 2K 水性 PU 防涂鸦涂料的发展

Development of Low VOC 2K Waterborne PU Anti-Graffiti Coatings

低 VOC 2K 水性聚氨酯防涂鸦涂料的开发，满足使用较少量溶剂的低气味配方的工业需求。配方平台方法有效地使用许多配方参数来探索和优化膜性质。异氰酸酯组成、NCO / OH 比例和氟含量百分比等对抗涂鸦性能的影响，表面和体膜性能与抗涂鸦性能相关。掺入特定的异氰酸酯以获得阻隔性能和表面的氟含量是获得优异的抗涂鸦性能的最重要因素；此外，这些水性涂料具有优异的重涂性和优异的耐化学性。

A low VOC 2K waterborne polyurethane anti-graffiti coating has been developed to address the industrial needs for low odor formulations using less amount of solvent. The formulation platform methodology has effectively been applied to explore and optimize the film properties with a number of formulation parameters. The effect of isocyanate composition, NCO/OH ratio, and percentage of fluorine content on anti-graffiti performance has been studied. The surface and bulk film properties have been correlated with the anti-graffiti properties. It is found that incorporating specific isocyanate to achieve barrier properties and the fluorine content at the surface are the most important factors for excellent anti-graffiti performance. In addition, these waterborne coatings demonstrate excellent recoatability and exceptional chemical resistance.

第三节 SESSION III

4.12.2018 (星期二 Tuesday) • 13:00 – 17:00



章明秋教授
Prof. Ming-Qiu Zhang
中山大学材料科学研究所，
广州，中国
Materials Science Institute of
Sun Yat-sen (Zhongshan)
University, Guangzhou, China

水下自愈合聚合物 Underwater Self-Healing Polymer

随着结构聚合物材料在造船、近海和组织工程（支架）中的应用增多，它们在水下或潮湿环境中通过自我修复从而恢复强度的能力成为一个主要议题。然而，到目前为止，由于缺乏合适解决方案，关于这方面的研究报道很少。例如，对于外加愈合剂进行自修复的策略，催化剂易于在水中失活或释放的愈合剂反应将被水抑制；而就利用可逆键的本征型自愈合聚合物而言，因其通常是疏水性的，裂纹表面上的大分子链倾向于在水中收缩，不利于它们在界面间扩散和碰撞。因此，必须提出聚合物结构的创新设计和工作原理才能解决面临的挑战。

主题论文 KEY NOTE PAPER 9

With the increasing application of structural polymeric materials in shipbuilding, offshore and tissue engineering (scaffolds), their ability of self-healing in water or wet environment towards strength restoration becomes an important issue. So far, however, there have been rare reports concerning the researches in this aspect because of lacking suitable solutions. In the case of extrinsic self-healing based on embedded healing agent, for example, either the catalyst would be deactivated or the reaction of the released healing agent would be inhibited by water. With respect to intrinsic self-healing polymers utilizing reversible bonding, which are often lipophilic, the macromolecular chains on the cracked surfaces tend to shrink in water, preventing their diffusion and collision across the interface. Therefore, innovative design of polymer structure and working principle has to be put forward.



胡剑青博士
Dr. Glenn Hu
华南理工大学化学与化工学院，
广州，中国
South China University of
Technology, Guangzhou,
China

防污长效抗菌阳离子聚氨酯分散体涂层 Synthesis and Characterization of Anti-Smudge and Long-Lasting Anti-Bacterial Cationic Polyurethane Dispersion

抑制细菌生长和防污是涂料业关注的议题，研究具有长久抗菌性和高耐沾污的水性聚合物涂料非常具有应用价值，制备的涂料要求具有非常优异的长久抗菌性能，而且兼具拒水、拒油、防沾污和耐磨性，以及对基材具有良好的附着力。为了实现该目的，本文将在阳离子水性聚氨酯的合成基础上，引入低表面能的聚醚二元醇和具有抗菌性的反应性单体 - 六氢 -1,3,5- 三 (羟乙基) - 均三嗪两种化合物进行改性，从接触角、滚动角、防污、自清洁、耐老化、耐腐蚀、抗菌活性等各方面探讨不同配方的影响。

论文 PAPER 10

The inhibition of bacterial growth and smudge resistance is a topic of concern for the coatings industry. It is of great value to study aqueous polymer coatings with long-lasting antibacterial properties and high smudge resistance. The prepared coating is required to have excellent long-term antibacterial properties, and has both water and oil repellency, anti-smudge, abrasion resistance and good adhesion to the substrate. To achieve this goal, polyether polyol with low surface energy and reactive antimicrobial monomer-hexahydro-1,3,5(hydroxyethyl)-s-triazine (TNO) were modified into the polymer chain of cationic waterborne polyurethane. The properties of the polymer films such as contact angle, rolling angle, anti-smudge, self-cleaning, anti-aging, anti-corrosion, antibacterial activity are discussed according to the synthesis formulations of the cationic waterborne polyurethane.



Dr. Moreillon Olivier
博士
研发总监 R&D Director
Ecoat, 法国
Ecoat, France

具有出色建筑和工业涂料性能的生物基醇酸乳液 Biobased Alkyd Emulsion with Outstanding Performances for Architectural and Industrial Coatings

全球涂料业正面临可持续发展和全球变暖的挑战。因此，消费社会正寻求越来越多环保产品。对于水性、高固体含量、粉末或辐射固化技术，已广泛研究使用较少或甚至没有挥发性有机溶剂的技术。在这种背景下，因为以可再生原材料的缩聚反应获得的基料，水性醇酸树脂涂料正在大规模卷土重来。我们将介绍生物基醇酸乳液（50 至 98% 生物基）和聚氨酯醇酸树脂分散体（生物基含量高达 68%）的最新发展，它们具有出色的建筑、木材和防腐 / 金属应用性能。

论文 PAPER 11

The global coatings industry is facing the sustainability and global warming challenge. As a result, the consumer society is seeking for more and more eco-friendly products. Therefore technologies using less, or even no, volatile organic solvents have been widely investigated towards water-borne, high solids, powder or radiation cure technology. In this context, waterborne alkyd coatings are making a huge comeback, because based on a binder obtained by polycondensation reactions of renewable raw materials. We will present hereafter its last developments on biobased alkyd emulsions (50 to 98% biobased) and polyurethane alkyd dispersions (biobased content up to 68%) with outstanding performances for architectural, wood and anti-corrosion/metal applications.



Mr. Carlos Feito Fraile
先生
技术总监 Technical Director
海名斯特殊化学，德国
Elementis GmbH, Germany

应用于工业涂料及建筑材料体系的新一代流变剂 Next Generation of Thickeners in Industrial Coatings & Construction Systems

论文 PAPER 12

流变特性对于工业涂料、胶粘剂或密封胶来说至关重要。一个精心配制的工业涂料、胶粘剂或密封胶具有平衡的流变特性，易于施工但可控，良好的抗流挂或抗塌陷及储存稳定性。增稠剂在涂料、胶粘剂或密封胶配方中提供生产者能够设计符合自己特定需求的流变特性的能力。

The rheological properties of an industrial coating, adhesive or sealant are vital to its success. A well formulated industrial coating, adhesive or sealant has balanced rheological properties, easy but controlled application, good sag or slump resistance and storage stability. The thickeners incorporated in the coating, adhesive or sealant formulations provide the manufacturers the ability to design the rheological characteristics they need for specific end use.

有机触变剂是以蓖麻油或者聚酰胺为基础材料，特别适用于工业涂料、建筑密封胶、填缝胶、胶粘剂等体系。这些添加剂在剪切稀化、粘度增加、流挂控制和颜料悬浮等方面提供了出色的效率。然而，较高的活化温度有时制约了其广泛的应用。在本论文中，我们展示了新一代可在较低温下活化的高效有机触变剂。这些新材料可成功应用在工业涂料或密封胶配方，获得更好的粘度构建、抗流挂和更高的挤出率。它们展现更宽的操作工艺窗口，并可能可以降低生产能耗。

Organic thixotropes are castor oil or polyamide based materials that are especially useful in systems such as industrial coatings, construction sealants, caulk, adhesives, and mastics. These additives provide outstanding efficiency for shear thinning, viscosity build, sag control, and pigment suspension. However, the high activation temperature is sometimes a deterrent for a broader use. In this paper, we present a new generation of highly efficient organic thixotropic based thickeners that can be activated at significantly lower temperatures. These new materials can be successfully incorporated in industrial coatings or sealant formulas for better viscosity build, sag resistance and higher extrusion rates. They display a wider process window and may require less energy in production.



曲清蕃博士 Dr. Chris Chiu
董事长 Chairman
奇钛科技股份有限公司，
台北，台湾地区
Chitec Technology Co., Ltd.,
Taipei, Taiwan Region

雨水对水性紫外光安定剂的影响 The Effect of Rainfall on Waterborne UV Stabilizers

论文 PAPER 13

水性紫外光安定剂近年越来越多人使用，因越来越多溶剂型室外涂料转成水性。水性紫外光安定剂可分为两大类：水混合型和乳化型。最近，相对水混型，乳化型吸引更多关注，因后者不但没有 VOC，而且不需要用到助溶剂来提高兼容性。除以上两项优点外，本论文将报道另外一项乳化型的巨大优点，就是对雨水的抵抗力比水混合型更优秀。这优点在聚酯薄膜、聚碳酸酯板、彩钢板、木板等四个含有紫外光安定剂涂料的光老化实验中显现，不论对颜色和光泽度的保护均较水混型更优秀。

Waterborne UV stabilizers have gained popularity over the last few years as more solvent-borne exterior coatings have been converted into waterborne ones. Waterborne UV stabilizers are of two major types: water-miscible and emulsified. Recently, the emulsified version has attracted more attention due to their VOC-free and more easily miscible without the need of co-solvents. This paper reports another significant advantage of emulsified UV stabilizers. They have more resistance to rainfall than the water-miscible products. From the weathering experiments with four waterborne coatings on PET film, PC sheet, colour steel plate and wood, we were able to demonstrate that the emulsified UV stabilizers provided superior resistance to the deterioration of colour and gloss.

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(852) 2865 0062

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