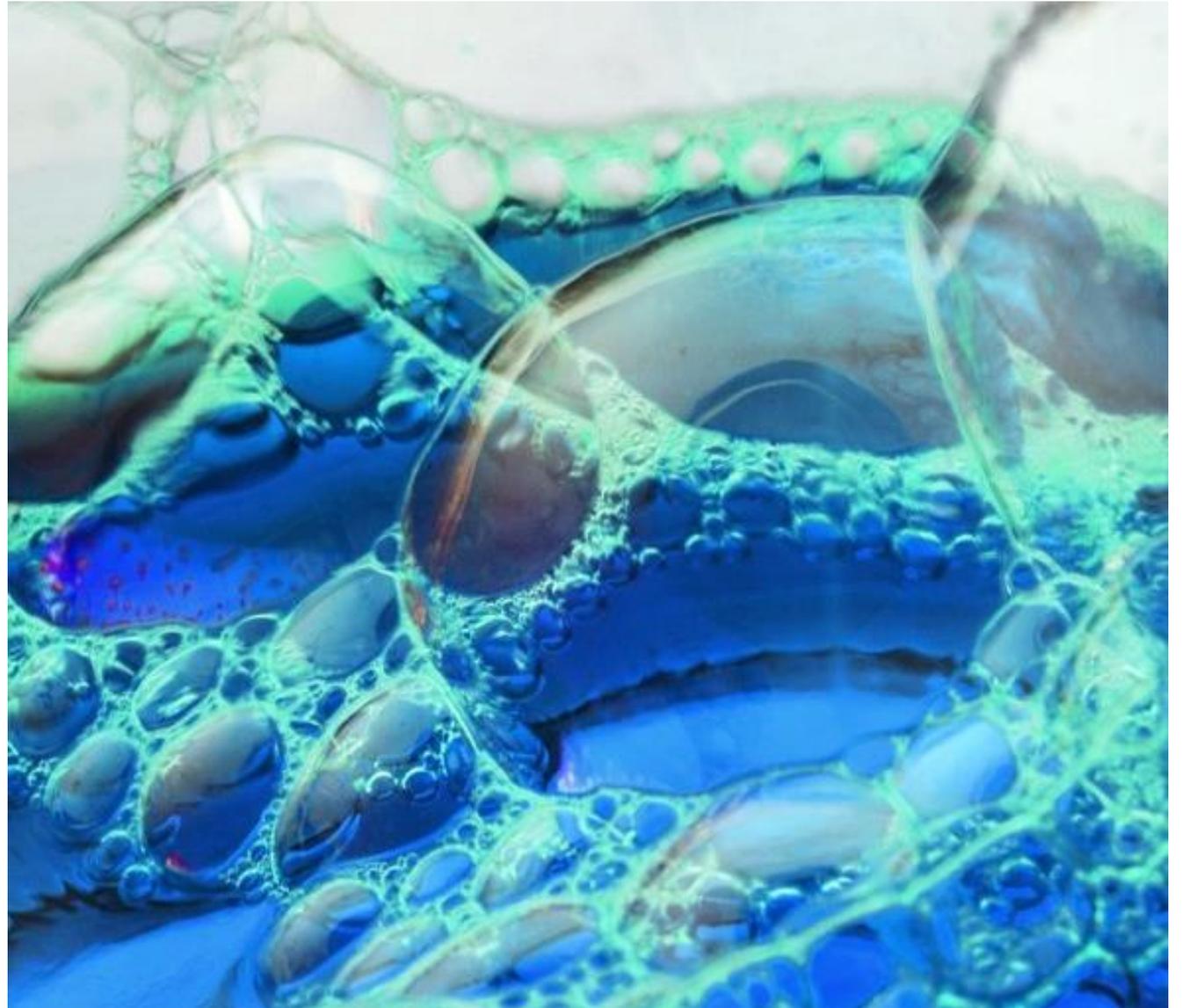


Food Contact Compliant Defoamers & Deaerators for Waterbased Coatings and Inks

Dr. Ingrid K. Meier, Head of Applied Research
& Technology Americas, Decorative Coatings
Coating Additives, Evonik Corporation
July 2021



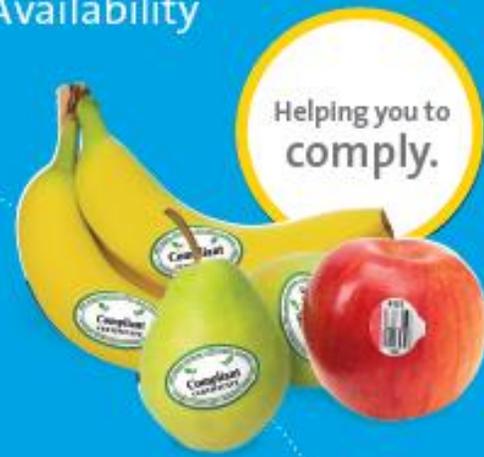
Agenda

- The importance of global food contact compliances
- Key US FDA indirect food contact compliances
- Defoaming & deaerating mechanisms
- Evonik's defoamers and deaerators with key food contact compliances

Additive solutions to meet your performance and food contact regulatory requirements

Innovation
Partnership
Performance
Availability

Helping you to comply.



Demand for Food Contact Compliances is Increasing

Market Trends



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

- Growing awareness regarding the safety of substances that may come in contact with food
- Regulations and restrictions related to food contact exist in North America, South America, Europe, China and Japan

Customer Demands



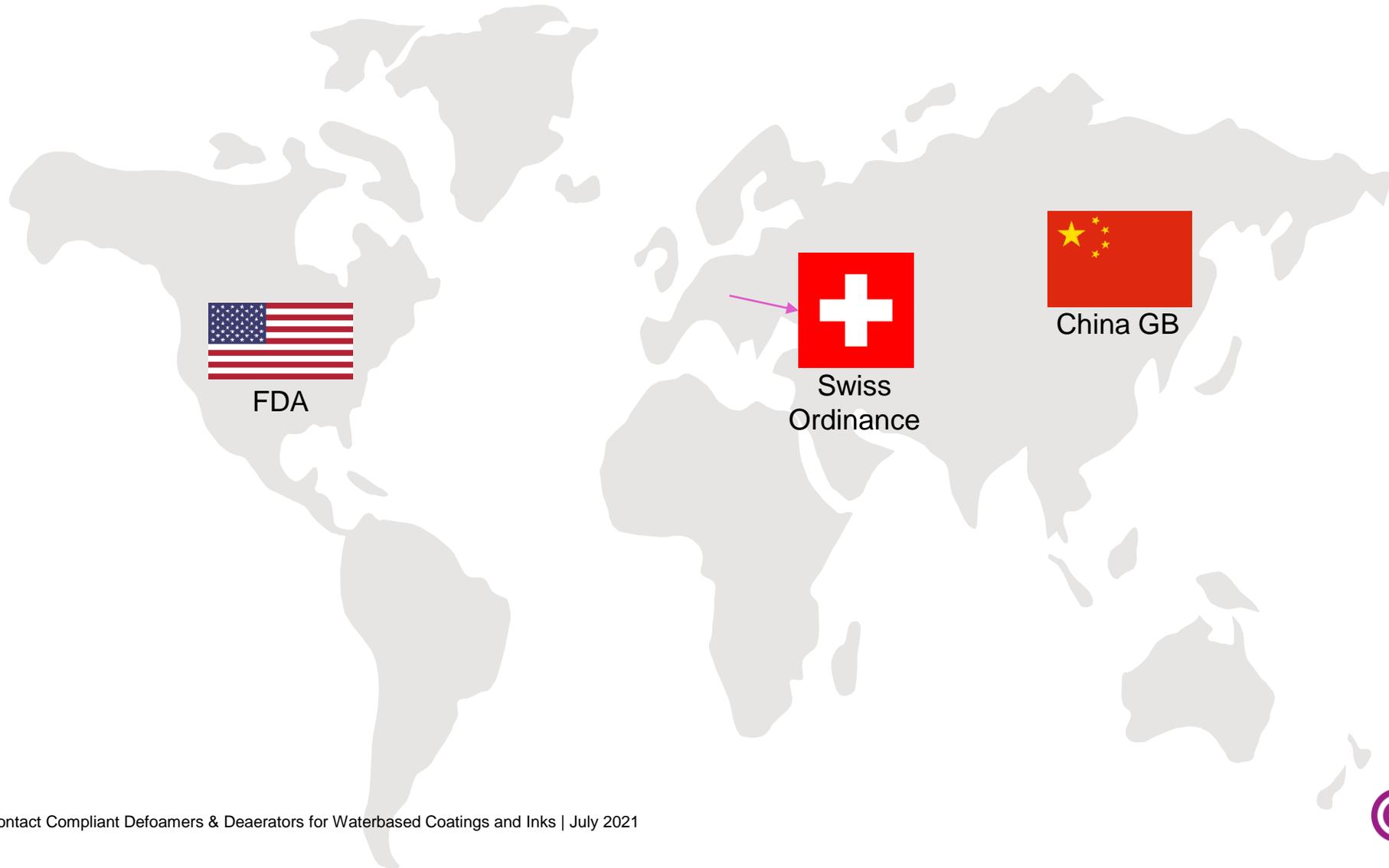
- Increasing desire to sell the same product globally
- Application performance remains the determining factor

Evonik Solutions



- Introduce products that have broad indirect food contact compliances
- Ensure products meet customers' performance requirements

Compliance with Regional Food Contact Regulations is Important





Food Contact Status FDA

Information can be found in the Food Contact Information Sheet

USA: FDA Regulations

AIRASE® 5355 may be used in compliance with FDA 21 CFR 175.105 and FDA 21 CFR 175.300. It also may be used in compliance with FDA 21 CFR 176.170 and 176.180, if used as defoamer.

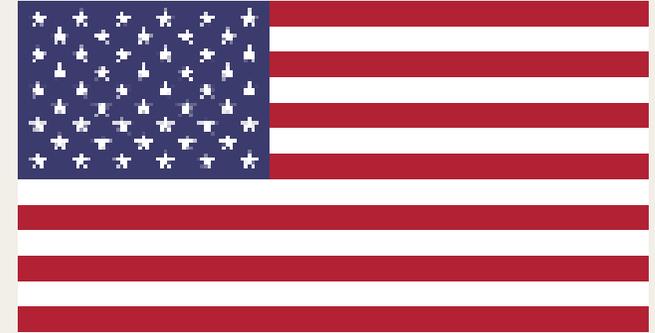
Example Screen Shot from one of our Food Contact Information Sheets

FDA = Regulations of the U.S. Food and Drug Administration

The FDA has regulations for various applications like paper & board, polymer dispersions, adhesives, etc.

Especially requested for can coil coatings: § 175.300

Especially requested for food packaging inks: § 175.300, 176.170, 176.180



Various paragraphs describe the criteria for safe use of certain food contact materials according to US law



Food Contact Status Swiss Ordinance

Information can be found in the Food Contact Information Sheet

Switzerland: SR 817.023.21

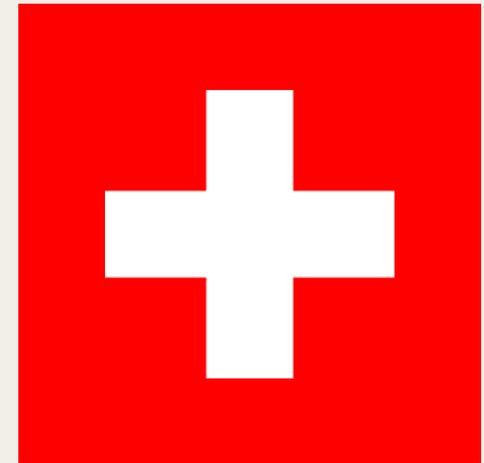
AIRASE® 5355 is in compliance with the “Ordinance of the FDHA on Materials and Articles (SR 817.023.21)” – status 1 December 2019. All components (additives and / or monomers) are listed in Annex 10 in the lists for evaluated (A) substances.

Example Screen Shot from one of our Food Contact Information Sheets

Central elements of the “**Swiss Ordinance**” are the “positive lists” A (evaluated substances) and B (not evaluated substances which have a 10 ppb limit).

Preferable properties for safe use in food contact applications:

- All components (and/or the monomers of polymers) are listed on list A
- Avoid substances with restrictions
- High molecular weight (>1000 Da) prevents from migration and toxicological potential



The “Swiss Ordinance” applies to inks for food packaging and includes positive lists for raw materials and building blocks



Food Contact Status China GB 9685-2016

Information can be found in the Food Contact Information Sheet

China: GB 9685 – 2016

AIRASE® 5355 is in compliance with GB 9685 for paper only with no restrictions.

Example Screen Shot from one of our Food Contact Information Sheets

GB 9685-2016 National Food Safety Standard:

- Standard for the Use of Additives in Food Contact Materials
- Came into force on 19 Oct 2017, replacing GB 9685-2008
- Divided into 7 chapters dealing with various end applications
- Contains “positive lists” of additives that can be used to produce various food contact materials and articles, including their use scope and restrictions
- The list dealing with printing inks is to be found in appendix A7
- New additives or new applications currently not included in GB 9685-2016 have to be approved by the National Health and Family Planning Commission (NHFPC) prior to use



Various paragraphs describe the criteria for safe use of certain food contact materials according to Chinese Law

US FDA Compliances

- The FDA regulations are written for specific applications
 - Requirements and compliances may be difficult to understand; consult the actual regulation(s)
 - Knowledge of full chemical compositions (including impurities and by-products) is required to make an assessment
 - Often outside legal experts (i.e., Steptoe, Intertek, Keller & Heckman) are hired to make these assessment
 - Can be very expensive to perform testing and to obtain compliance for new molecules like additives
- Compliance with one FDA code almost never implies compliance with another
- Compliance can have restrictions on additive usage
 - Use level, specific application methods, end-use conditions, etc.
 - ***Customers must ensure that they are complying with these regulations and restrictions***
- Many older commodity additives have compliances, but fewer high-performance additives have compliances

Evonik's Coating Additives portfolio offers a broad range of options

Reach Out to Evonik's Regulatory Guidance Group for Assistance

- Food Contact Information Sheets on our website are guides for initial investigation only
 - Specific food contact compliances for a product may be mentioned
 - An official letter from Evonik's Regulatory Guidance group should be requested
 - Additional details related to compliances and restrictions will be articulated in the letter

January 7, 2021

AIRASE® 5355

Food Contact Information

EU: Regulation 10/2011

AIRASE® 5355 is in compliance with EU-Regulation 10/2011 on plastic materials and articles intended to come into contact with food and its amendments without restriction.

BfR Recommendation XIV

The components of AIRASE® 5355 are in compliance with BfR-Recommendation XIV.

Switzerland: SR 817.023.21

AIRASE® 5355 is in compliance with the "Ordinance of the FDHA on Materials and



June 13, 2017

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Subject: Compliance of TEGO® Foamex 1488

Dear Sir or Madam,

TEGO® Foamex 1488 may be used as a defoaming agent in adhesives, paper and paperboard and as a component in polymeric coatings, and is in compliance with 21 C.F.R. §§ 175.105, 175.125, 175.300, 176.170, 176.180, 176.200, or 176.210. The maximum concentration for all uses is 2.5% with a maximum film thickness (where applicable) of 0.5 microns. All of the components within Foamex 1488 are either listed within the specific CFR reference or calculations have confirmed will not exceed the threshold of migration when applying the FDA's default assumptions regarding quantity of food that is exposed to a food contact surface and standard FDA consumption factors.

Please let me know if you have any questions or require any additional information.

Best Regards,

Steven Mozucha
Product Regulatory Specialist
EHS&Q

21 CFR 175.300 - Indirect Food Additives: Adhesives and Components of Coatings - Resinous and Polymeric Coatings

- Covers formulation components of coatings used as the food-contact surface of articles intended for use in producing, manufacturing, packing, processing, preparing, treating, packaging, transporting or holding food
 - Blanket regulation for coatings that come into repeated contact with food such as can coatings and cookware
- One of the more restrictive regulations
- Very expensive to pursue new approvals

21CFR 176.170 and 176.180 – Indirect Food Additives: Paper and Paperboard Components

- Food packaging and handling – additives in the food contact surface whether coated or uncoated
 - 176.170 – components of paper and paperboard in contact with aqueous and fatty food
 - 176.180 – components of paper and paperboard in contact with dry food
- Note that 21 CFR 175.210 applies to Defoaming Agents used **in manufacture of** paper and paperboard

Mechanisms of Foam Stabilization, Defoaming and Deaeration



Macrofoam and Microfoam



Macrofoam

Located at the liquid surface
Can lead to poor surface appearance and defects



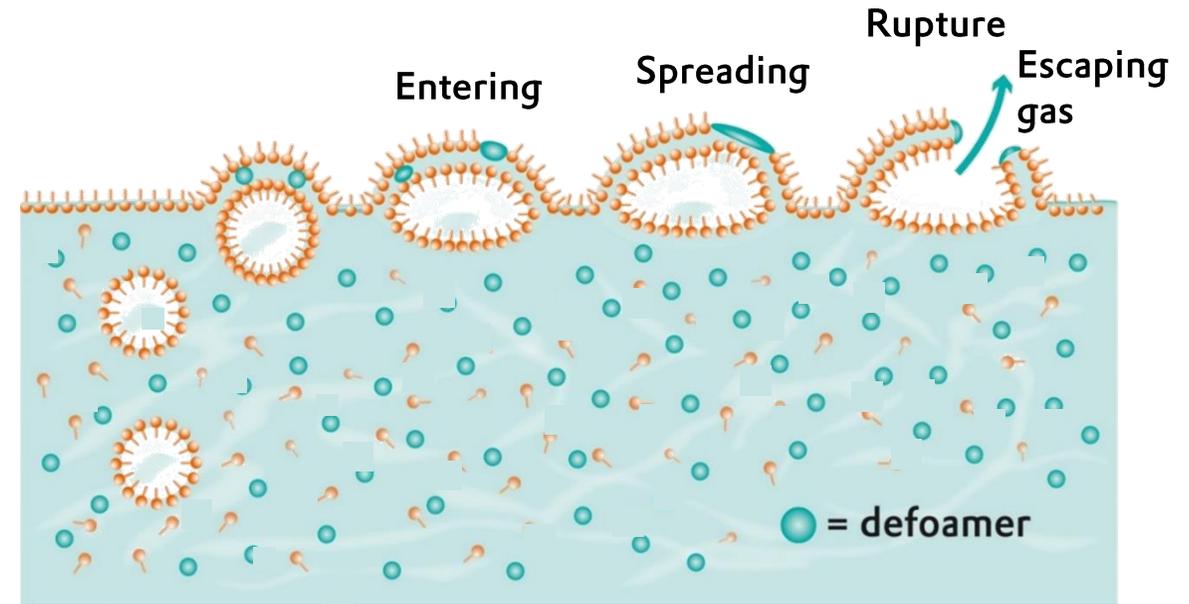
Microfoam

Located in the bulk liquid
Can lead to poor coating durability, haze, and pinholes



Foam Control with Conventional Defoamers

- Conventional defoamers' mode of action:
 - They must be incompatible with the system and, hence, form oil droplets
 - Their surface tension needs to be lower than that of the matrix
 - These droplets enter and spread within the foam lamellae and hence cause bubble rupture
- Conventional defoamer attributes:
 - Optimal defoamer droplet size is important
 - Generally strong defoamers with good “knock-down”
 - Defoaming strength and system (in)compatibility needs to be balanced to avoid defects in the coating



Thermodynamic requirements:

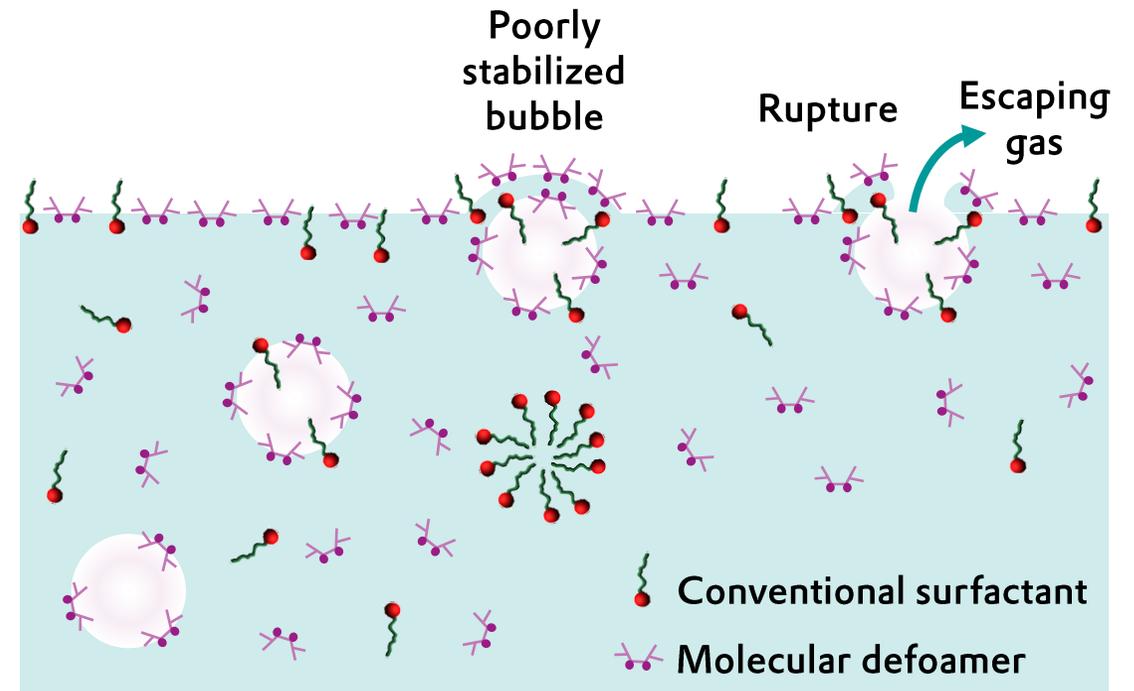
$$\text{Entering coefficient: } E = \gamma_l + \gamma_{l/o} - \gamma_o > 0$$

$$\text{Spreading coefficient: } S = \gamma_l - \gamma_{l/o} - \gamma_o > 0$$

γ_l = Surface tension of liquid
 $\gamma_{l/o}$ = Interfacial tension liquid/oil
 γ_o = Surface tension of oil

Foam Control with Molecular Defoamers

- Molecular defoamers act as surfactant anti-foams:
 - They must be sparingly soluble in the system without forming micelles like other surfactants
 - Mechanistic possibilities:
 - They have considerably faster surface tension dynamics than conventional surfactants
 - Their stronger adsorption coefficients drive molecular defoamers to new interfaces, displacing other surfactants
 - They are unable to stabilize foam lamellae; hence, the bubbles rupture even before foam can develop
- Molecular defoamer attributes:
 - Highly-branched, low molecular weight and hydrophobic (often Gemini-type) surfactants
 - Generally efficient prevention of foam formation
 - “Anti-foams”

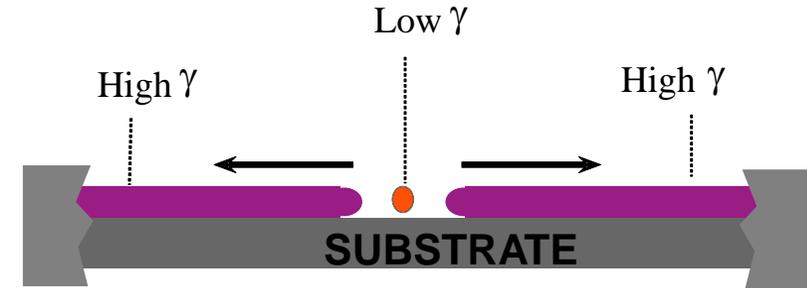


A Deaerator is a Specific Type of Defoamer That Can Attack Microfoam

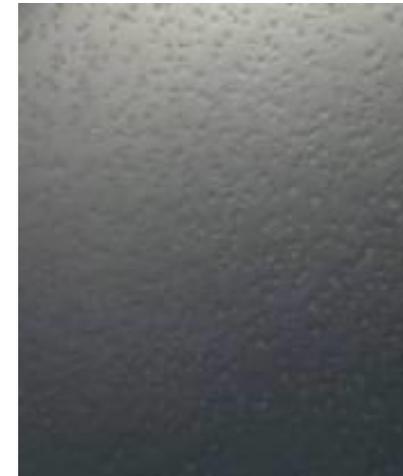
- Both defoamers and deaerators can defoam typical waterborne formulations
- Both defoamers and deaerators can be traditional oil based (i.e., siloxane-based) or surfactant based (molecular defoamers)
- The usual balance of defoaming strength and compatibility apply to both defoamers and deaerators
- Defoamers are most active at the surface of a liquid and are most effective against surface foam and bubbles (macrofoam)
 - They are usually less effective against gas bubbles below the surface (microfoam)
- Deaerators are chemically designed to be active against gas bubbles below the surface (microfoam) as well as surface foam
 - Deaerator molecules are slightly more water-soluble than conventional defoamers, enabling a higher concentration of deaerator molecules to be present in the bulk liquid

Foam Control: A Balance of Effectiveness and Compatibility

- Defoamers and deaerator incompatibility can result in coating defects
- Finding a proper balance is critical to destabilize foam but not destabilize the coating film
 - Extreme incompatibility can cause phase separation with little foam control
 - Moderate incompatibility can provide foam control but cause coating defects
 - Inadequate incompatibility provides limited foam control
 - Balance achieves foam control with no negative impact on coating film



Incompatible defoamer can cause craters and defects



Both Foam and Defoamers Can Cause Problems

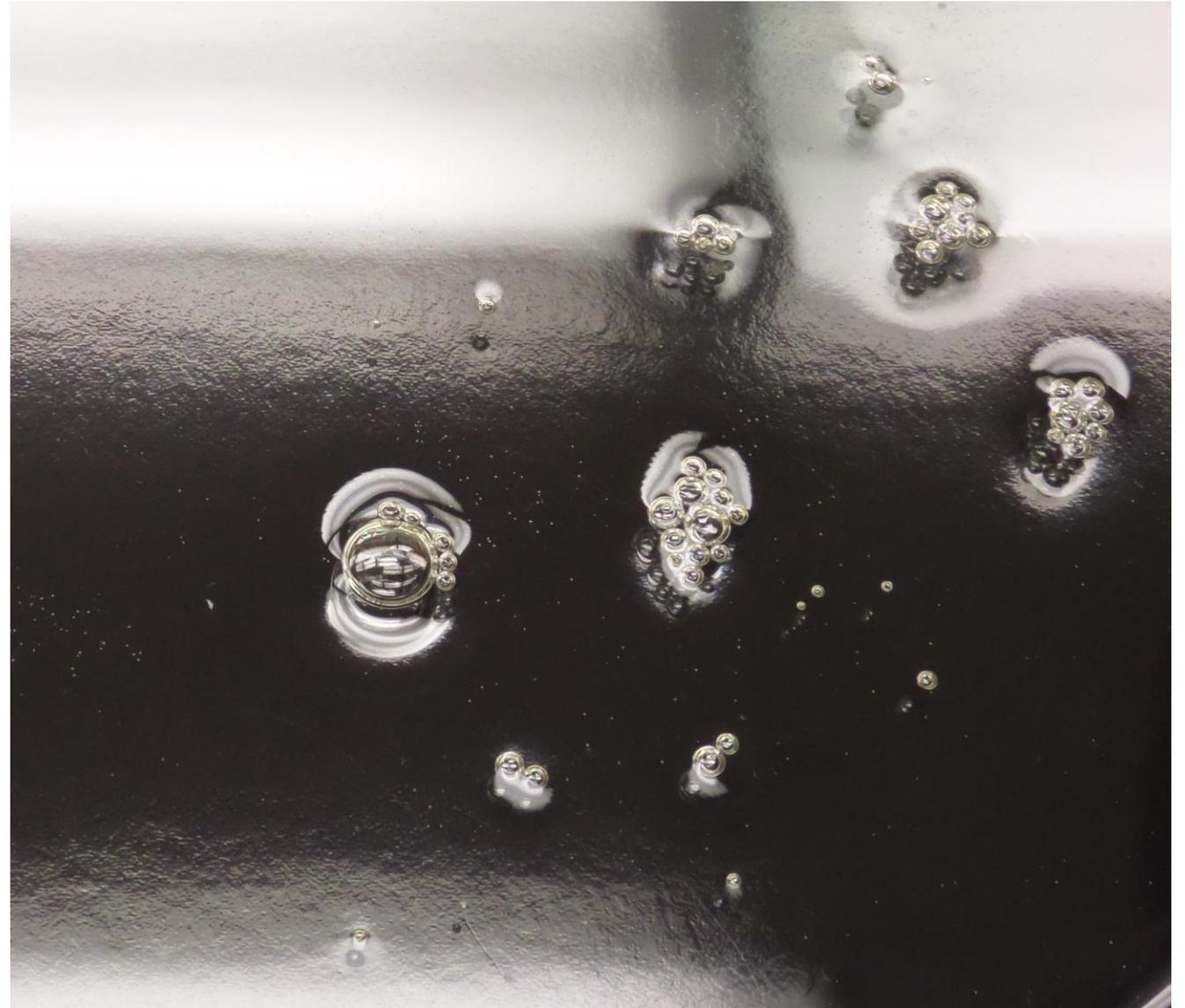
Problems Caused by Foam

- Poor Process Control
- Poor Aesthetics
- Pinholing
- Rough Surfaces
- Reduced Service Life
- Reduced Corrosion Resistance
- Poor Adhesion
- Skipped or missing dots (printing)

Problems Caused by Defoamers

- Craters
- Fisheyes
- Orange Peel
- Cissing
- Blisters
- Surface Defects
- Poor Recoatability

Evonik's Defoamers and Deaerators for Waterborne Coatings and Inks

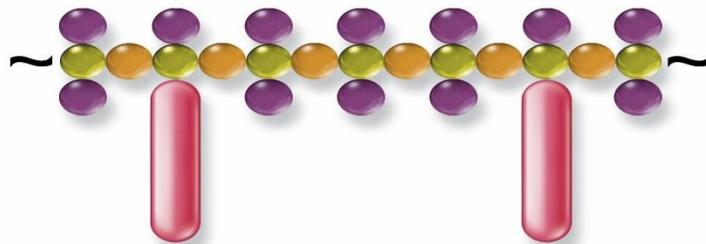
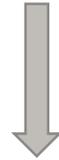


Organo Modified Siloxane Based Defoamers

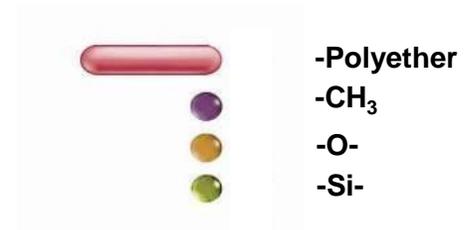


Silicone oil

Risk of Surface Defects !!!

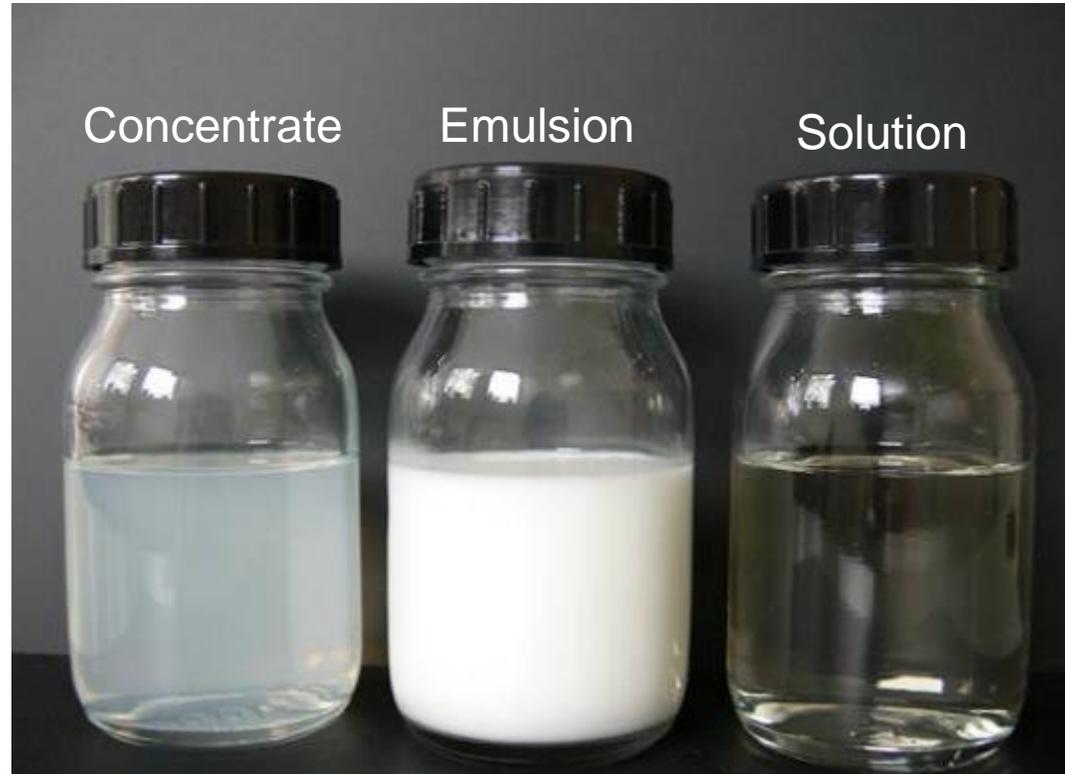


Polyethermodified Polysiloxane

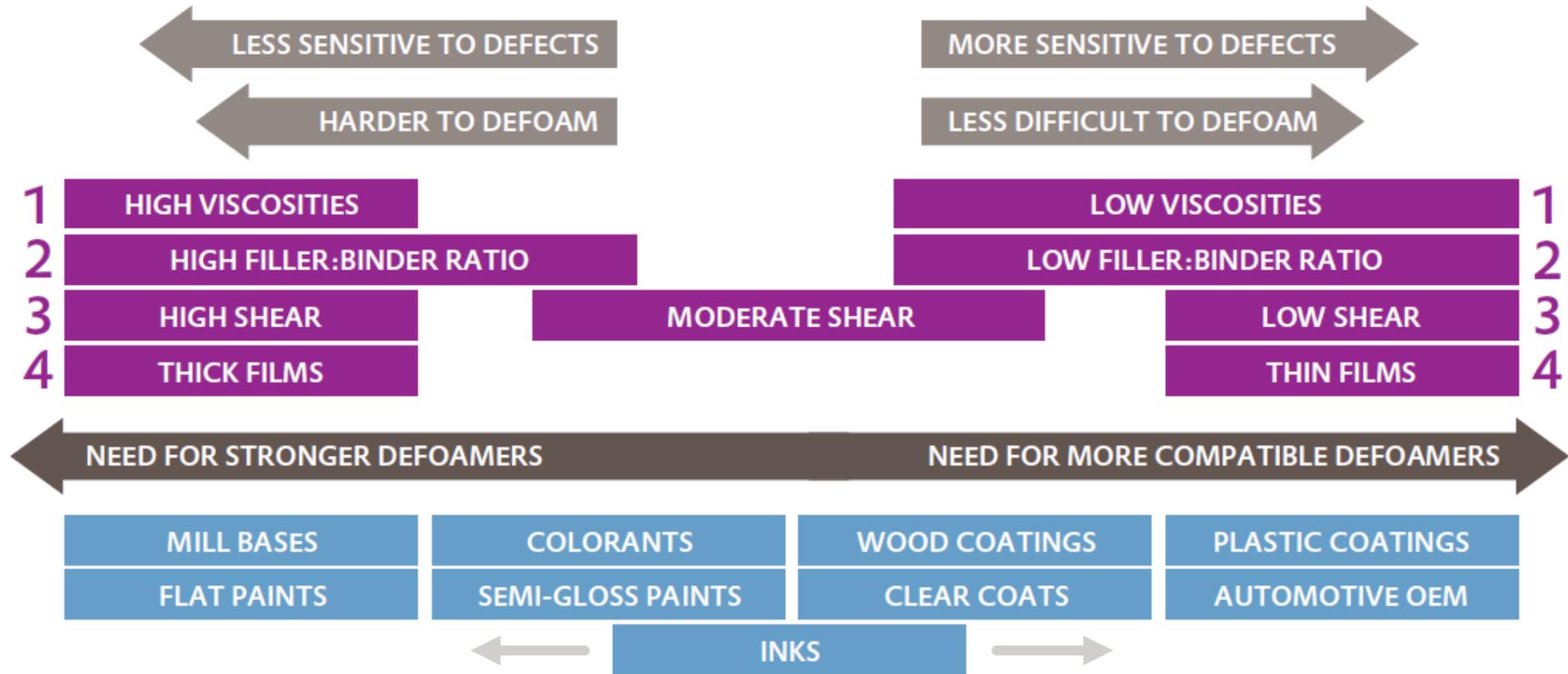


Siloxanes used for defoamers are usually relatively high in MW and fairly hydrophobic

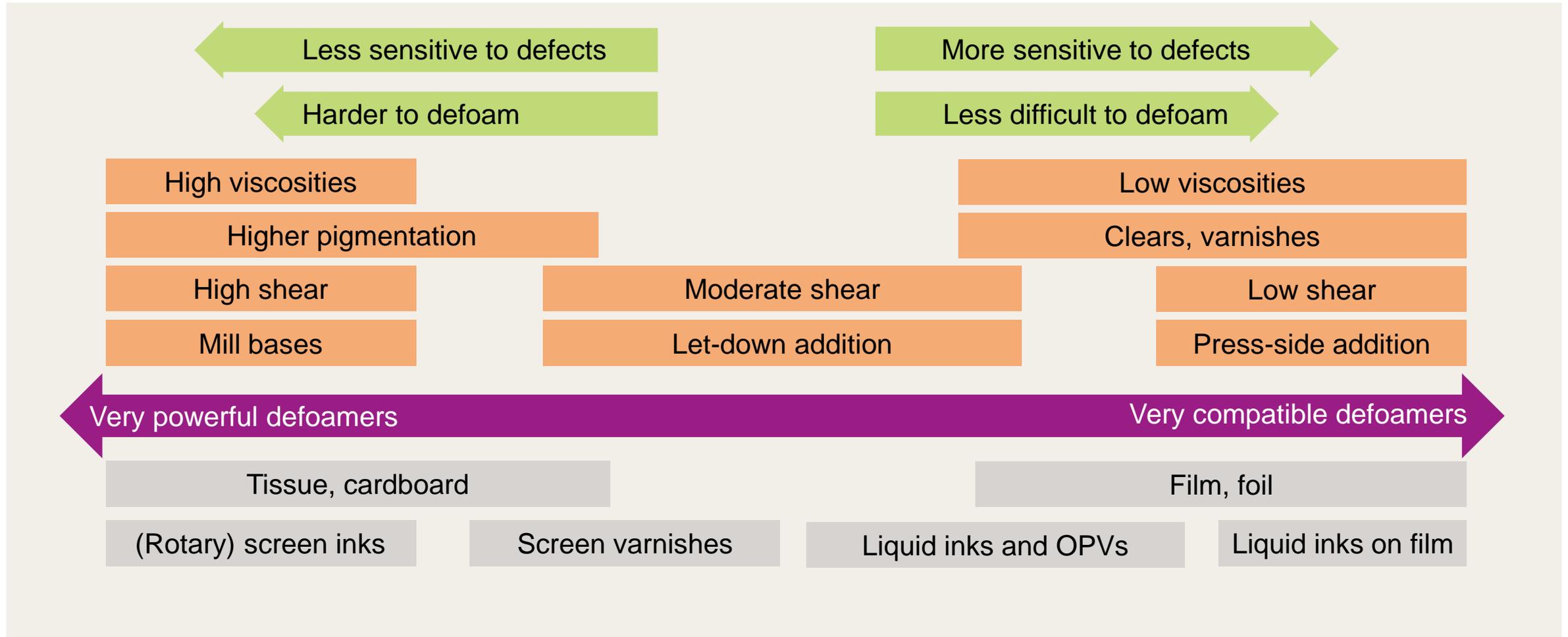
Defoamers and Deaerators May be Supplied in One of Three Forms



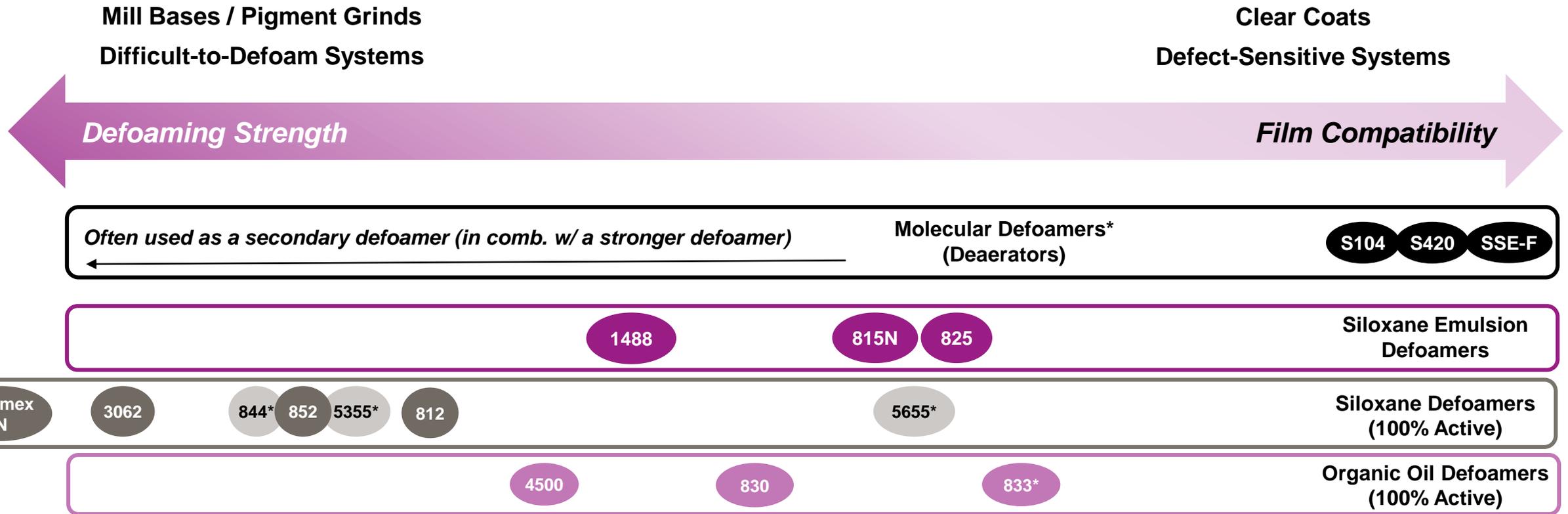
Defoamer Selection: First Understand the Formulation to be Defoamed



Defoamer Selection Criteria for Waterborne Printing Inks and OPVs: First Understand the System to be Defoamed

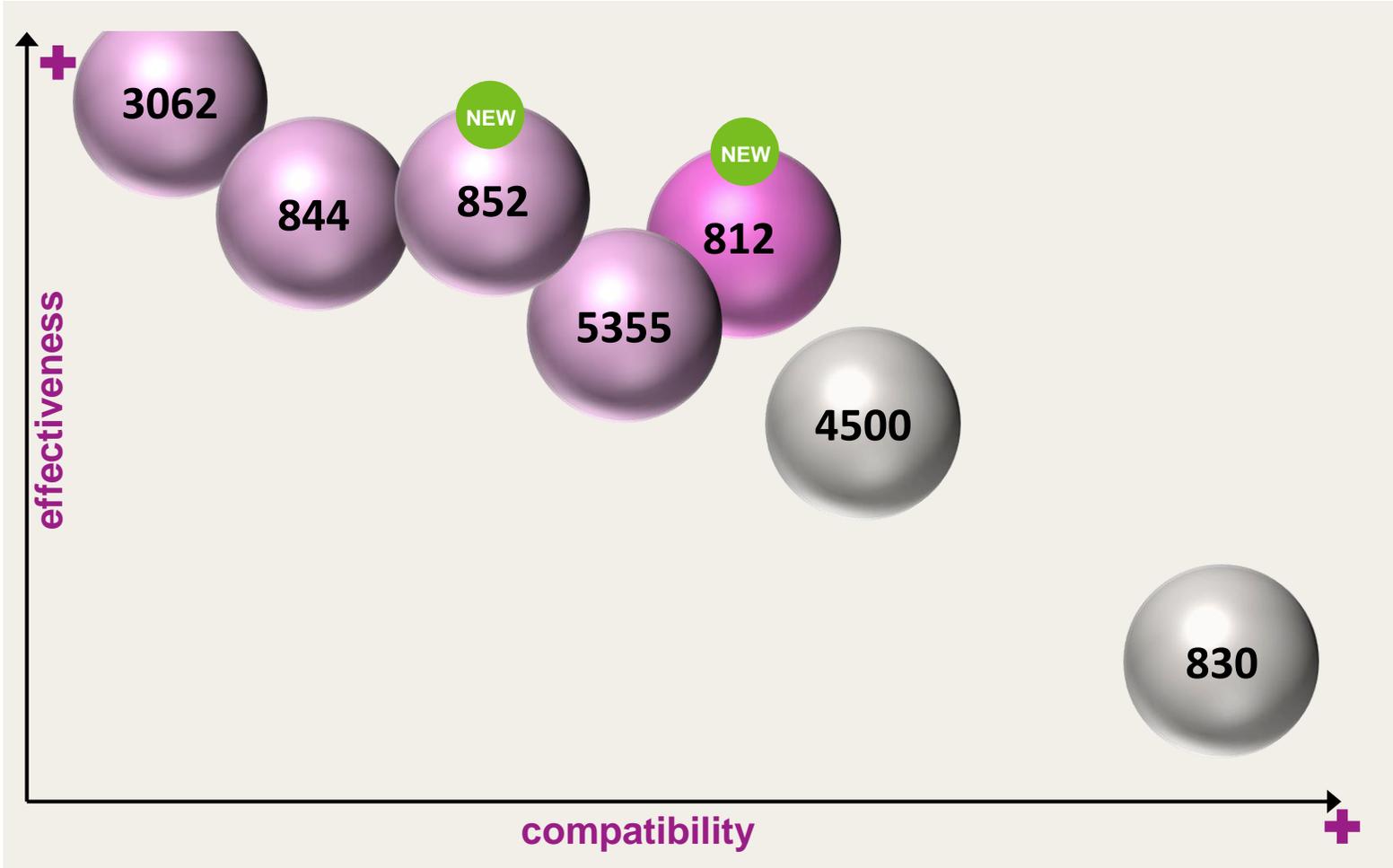


Food Contact Compliant Defoamers & Deaerators for Waterbased Coatings & Inks: Generalized Map Reflecting Relative Performance



Key: Molecular Defoamers Siloxane Emulsions Siloxane Defoamer 100% Active Silica-free Siloxane 100% Active Organic Oil Defoamers * = Silica-free

Food Contact Compliant Defoamers for Waterborne Coatings & Inks: Addition in the Grind Stage



Product Name	Swiss ordinance	FDA	China GB
TEGO® Foamex 3062	●	●	
TEGO® Foamex 844	●	●	●
TEGO® Foamex 852	●	●	●
AIRASE® 5355	●	●	●
TEGO® Foamex 812	●	●	
TEGO® Foamex 830	●	●	
AIRASE® 4500	●	●	

● beneficial

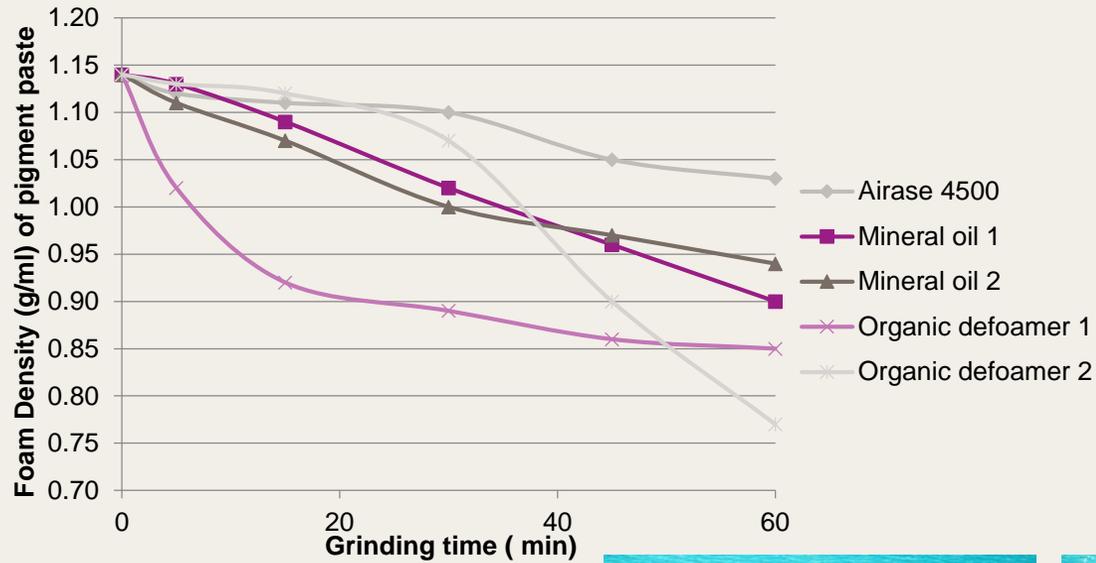
● Siloxane-based

● Siloxane-free



AIRASE® 4500 Outstanding Organic Oil-based Defoamer for Inks and Coatings

Effect of long term shear in P.R. 22 pigment paste



0.2 % Defoamer added to Flexo Ink applied on polyolefin films



AIRASE 4500



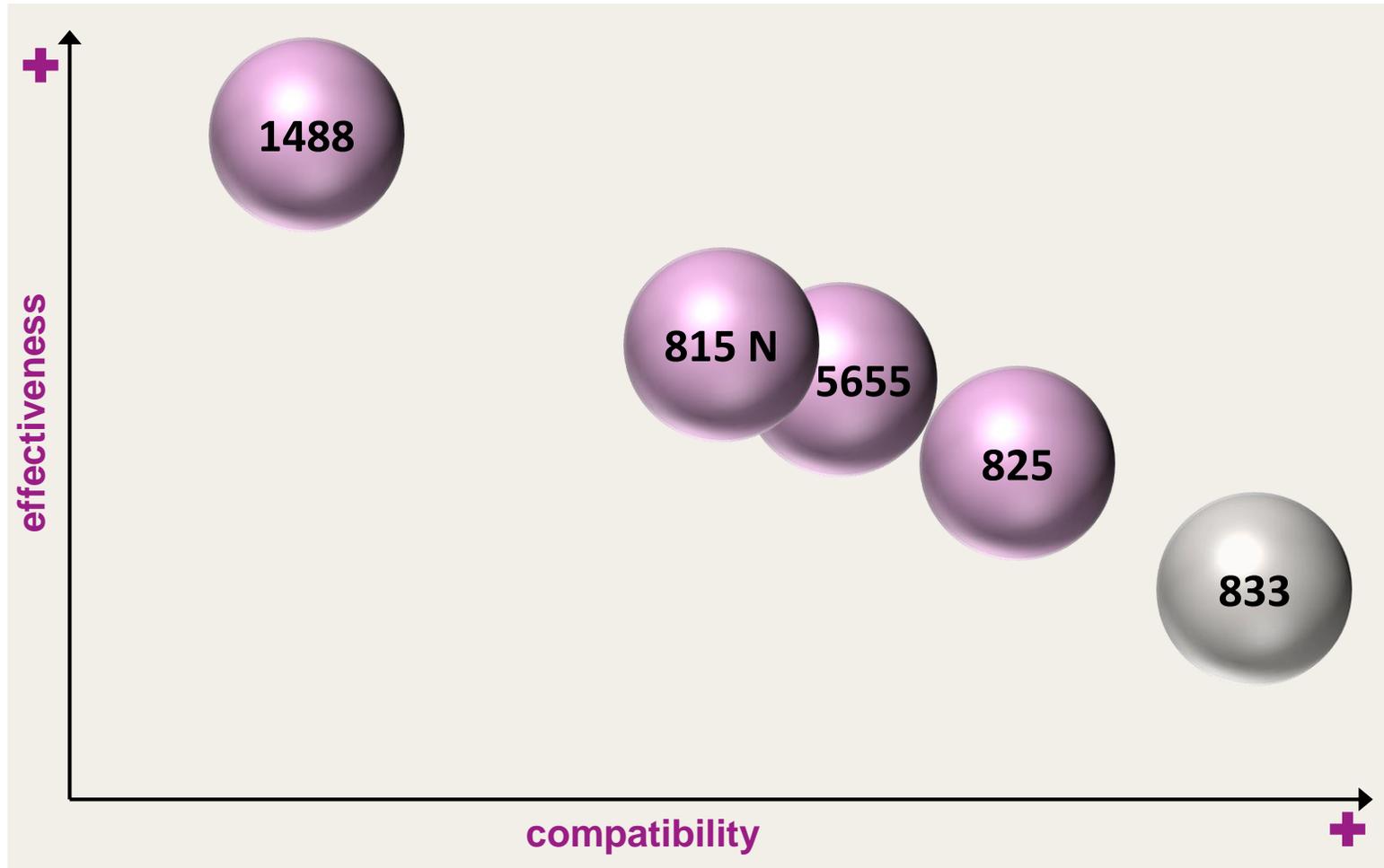
Siloxane Defoamer

Information

AIRASE®
4500

- Organic oil-based concentrate
- 100 % active matter
- Effective for pigment grinds, architectural and industrial coatings, printing inks and OPVs
- 22% Biobased (ASTM D6866-12)

Food Contact Compliant Defoamers for Waterborne Coatings & Inks: Addition in the Letdown Stage



Product Name	Swiss ordinance	FDA	China GB
TEGO® Foamex 1488	●	●	
TEGO® Foamex 815 N	●	●	
AIRASE® 5655	●	●	●
TEGO® Foamex 825	●	●	
TEGO® Foamex 833	●	●	●

● beneficial

● Siloxane-based

● Siloxane-free

Food Contact Status Overview for Waterborne Grinding Stage Defoamers

Product	Active Matter [%]	Siloxane containing	Swiss Ordinance	Nestlé Guidance	FDA 21CFR 175.300	FDA 21CFR 176.170	FDA 21CFR 176.180	China GB9685
TEGO® Foamex 3062	100	●	AB	●	●	●	●	
TEGO® Foamex 844	100	●	A	●	●	●	●	●
TEGO® Foamex 852	100	●	A	●	●	●	●	●
AIRASE® 5355	100	●	A	●	●	●	●	●
TEGO® Foamex 812	100	●	A	●	●	●	●	
AIRASE® 4500	100		A	●	●	●	●	
TEGO® Foamex 830	100		A	●	●	●	●	

● Can be used in compliance with this regulation; use level restrictions may apply

Status as per June 2021: This overview table is only for general information. For detailed information regarding a specific product please contact the Regulatory Guidance Team or refer to our Food Contact statements. Full list of food contact information can be found on our website via the link: <https://www.coating-additives.com/en/markets/printing-inks>



Food Contact Status Overview for Waterborne Letdown Stage Defoamers

Product	Active Matter [%]	Siloxane containing	Swiss Ordinance	Nestlé Guidance	FDA 21CFR 175.300	FDA 21CFR 176.170	FDA 21CFR 176.180	China GB9685
TEGO® Foamex 1488	20	●	A	●	●	●	●	
TEGO® Foamex 815 N	20	●	A+B	●	●	●	●	
AIRASE® 5655	100	●	A	●	●	●	●	●
TEGO® Foamex 825	20	●	A+B	●	●	●	●	
TEGO® Foamex 833	100		A	●	●	●	●	●

● Can be used in compliance with this regulation; use level restrictions may apply

Status as per June 2021: This overview table is only for general information. For detailed information regarding a specific product please contact the Regulatory Guidance Team or refer to our Food Contact statements. Full list of food contact information can be found on our website via the link: <https://www.coating-additives.com/en/markets/printing-inks>



Food Contact Status Overview for Molecular Defoamers

Product	Active Matter [%]	Siloxane containing	Swiss Ordinance	Nestlé Guidance	FDA 21CFR 175.300	FDA 21CFR 176.170	FDA 21CFR 176.180	China GB9685
SURFYNOL® 104	100		A	●	●			●
SURFYNOL® 104 PA	50		A	●	●			●
SURFYNOL® 104 PG 50	50		A	●	●			●
SURFYNOL® 104 Z	50		A	●	●			●
SURFYNOL® 420	100		A	●	●	●	●	●
SURFYNOL® SE-F	80		A	●	●	●	●	

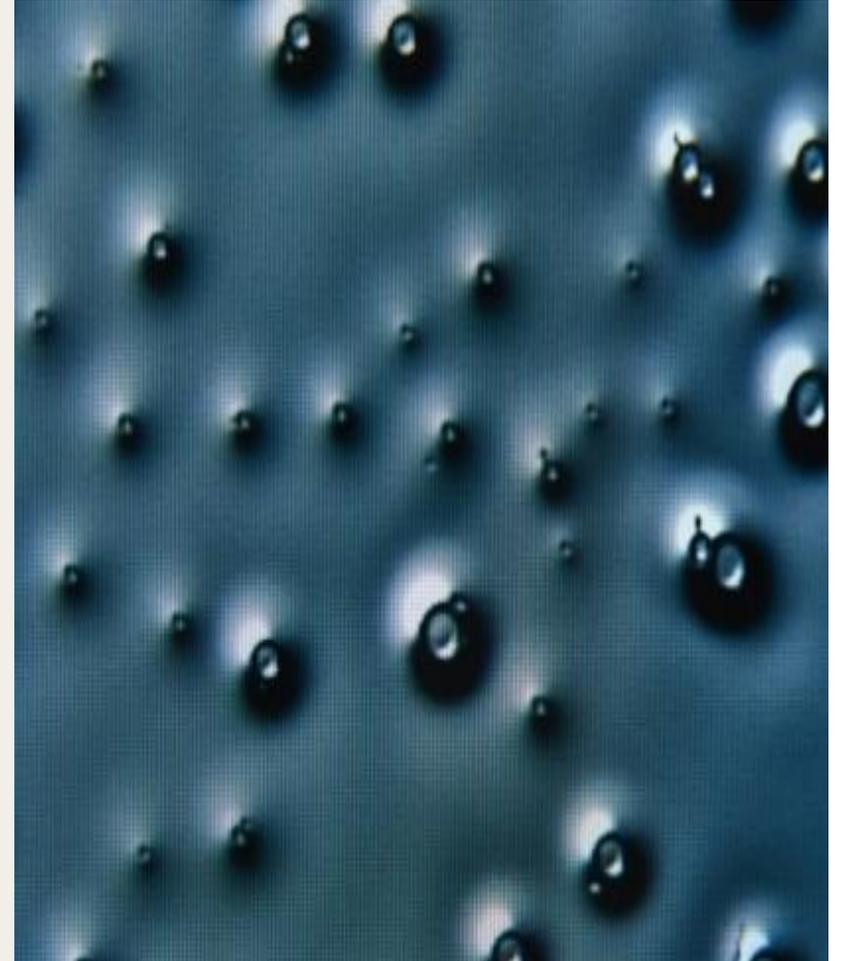
● Can be used in compliance with this regulation; use level restrictions may apply

Status as per June 2021: This overview table is only for general information. For detailed information regarding a specific product please contact the Regulatory Guidance Team or refer to our Food Contact statements. Full list of food contact information can be found on our website via the link: <https://www.coating-additives.com/en/markets/printing-inks>



Defoamers and Deaerators: Helpful Advice

- Often the best results are achieved with a combination of defoamer and deaerator
- Add the more incompatible defoamer / deaerator to the grind
- Add the more compatible one to the let down
- Add concentrates to the grind
- Add emulsions to the let down
- Incorporate incompatible defoamers / deaerators with high shear forces
- For some defoamers / deaerators, incorporation / compatibility may be improved by pre-diluting
- Wetting agents can improve the compatibility of defoamers / deaerators



Thank You!

OUR EXPERTS HAVE SOME FOOD FOR THOUGHT...

<https://www.coating-additives.com/en/responsibility>

**Regulatory-coating-additives-
americas@evonik.com**





EVONIK

Leading Beyond Chemistry