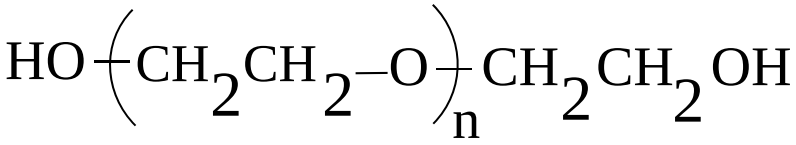
用于特种陶瓷的

DURAMAX™ 粘结剂和分散剂

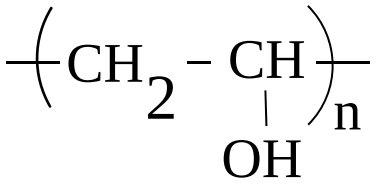
工业解决方案
陶氏家用与个人护理业务部

2010年12月

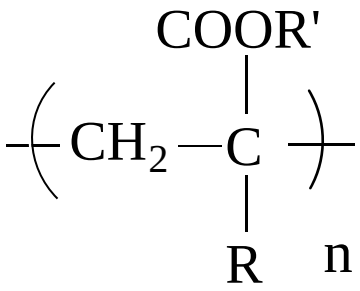
陶瓷粘结剂种类



PEG
聚乙二醇



PVA
聚乙烯醇



Acrylic Polymer
丙烯酸聚合物
(Duramax™)

R = H, CH
R' = others

Duramax™ 粘结剂

Duramax	Solids (%)	pH	Tg (°C)	Residue (%, air)	Application
B-1000	55	9.4	-26	0.40	Dry Pressing – Jiggering – Thick Tape
B-1001	55	9.4	-6	0.17	Jiggering
B-1002	45	2.6	-10	0.40	Thick Tape
B-1007	37	6.5	43	0.14	Dry Pressing
B-1014	45	3.0	19	0.45	Thick Tape
B-1020	43	8.6	29	0.41	Dry Pressing
B-1022	45	7.5	39	0.40	Dry Pressing - Jiggering
B-1033	100	/	105	41.0	Refractory
B-1043	50	3.0	105	8.5	Refractory
B-1043N	42.5	7.0			Refractory
B-1051	30	2.7	81	0.26	Refractory - Extrusion
B-1052	55	5.0	6	1.3	Extrusion
B-1070	44	6.2	-6	0.39	Thick Tape – Thin Tape
B-1080	44	6.5	-21	0.38	Jiggering – Thick Tape – Thin Tape

Duramax™ 分散剂

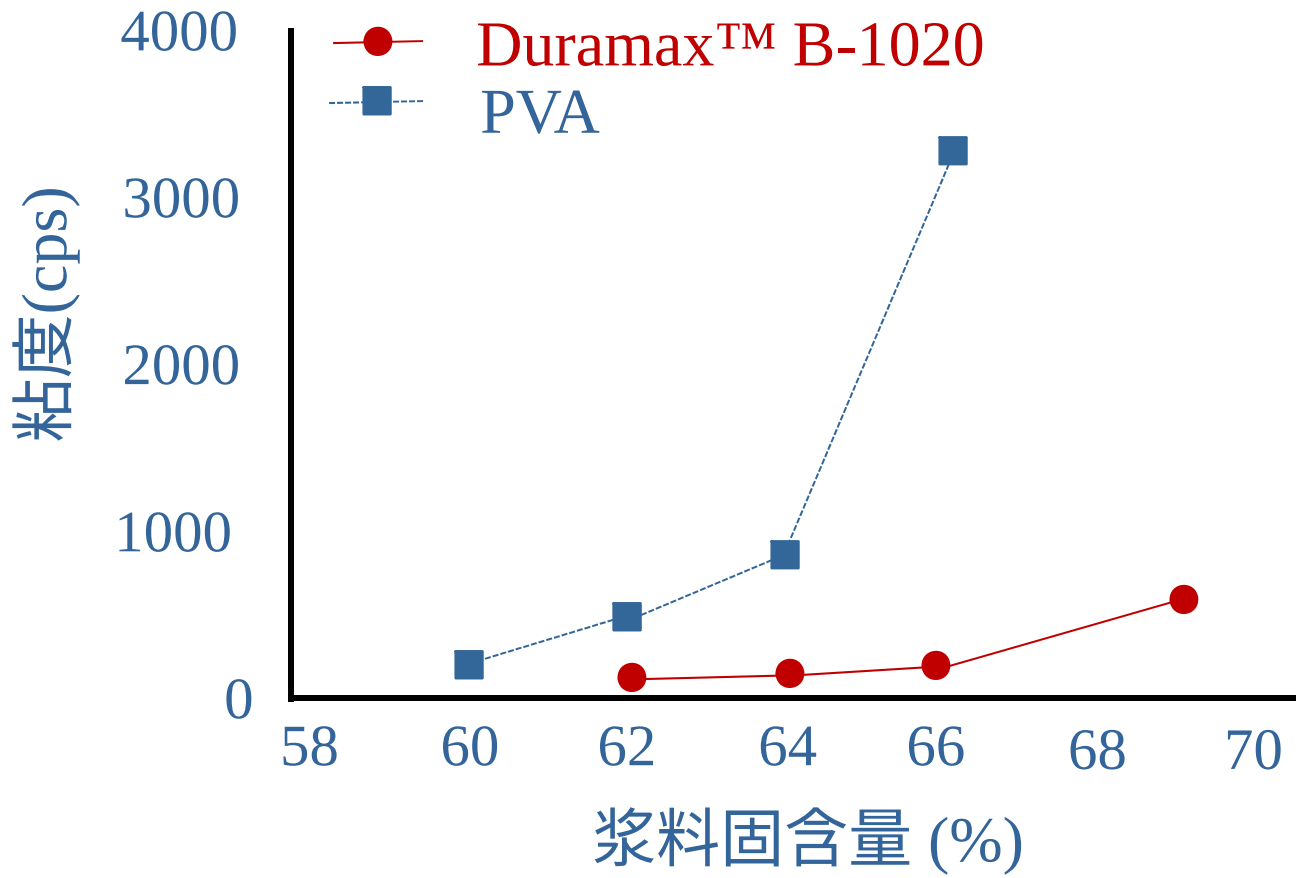
Duramax	Mw	pH	Counter ion	Solids (%)	Visco. (mPa.s)	Residue (%, air)	Application
D-3001	4500	7.0	Na	45	600	8.0	Tiles, low end technical
D-3005	2500	6.5	NH4	35	< 100	2.7	General purpose
D-3008	4500	2.5	Na	43	150	2.6	High water hardness
D-3019	2300	7.0	NH4	50	500	2.6	General purpose
D-3021	3000	7.5	NH4	40	< 100	< 0.2	Electronics (Na 18 ppm)

典型添加量: 0.1 – 0.3 % (dry/dry)

PVA类粘结剂可能导致体系粘度升高

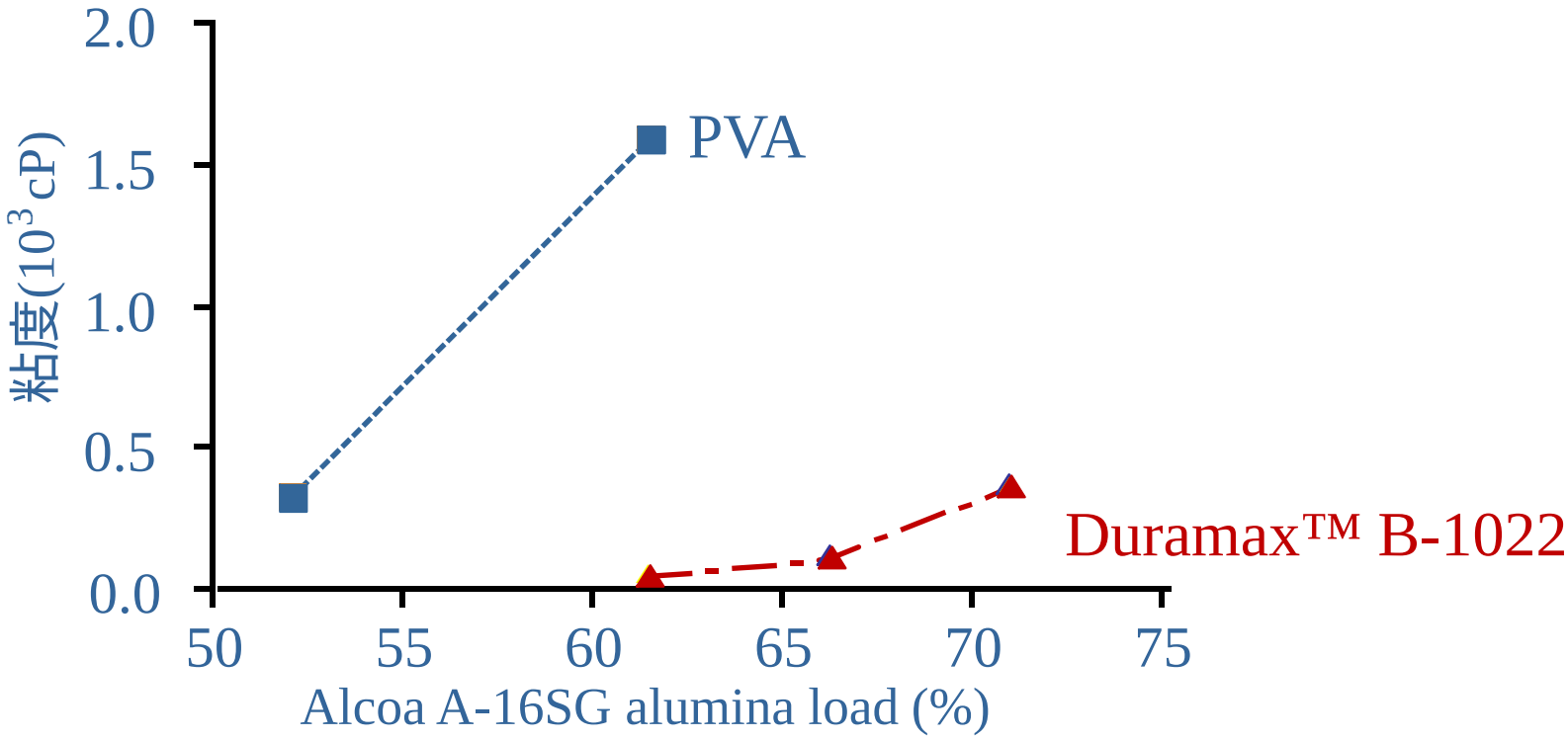
- PVA is a long chain solution polymer 长链溶液聚合物
  - Increased particle size, polymer bridging
    聚合物间的建桥作用导致体系中的粒子尺寸增大
  - Increased chain entanglement and viscosity
    聚合物链间的相互缠绕造成体系的粘度增加
- Acrylic emulsion binders are made of discrete particles
  丙烯酸乳液型粘结剂是由许多离散的颗粒组成
  - No chain entanglement
    没有聚合物间的链缠绕现象
  - Minimal increase in viscosity
    不会增加体系的粘度

Duramax™ 粘结剂能够提高浆料固含量



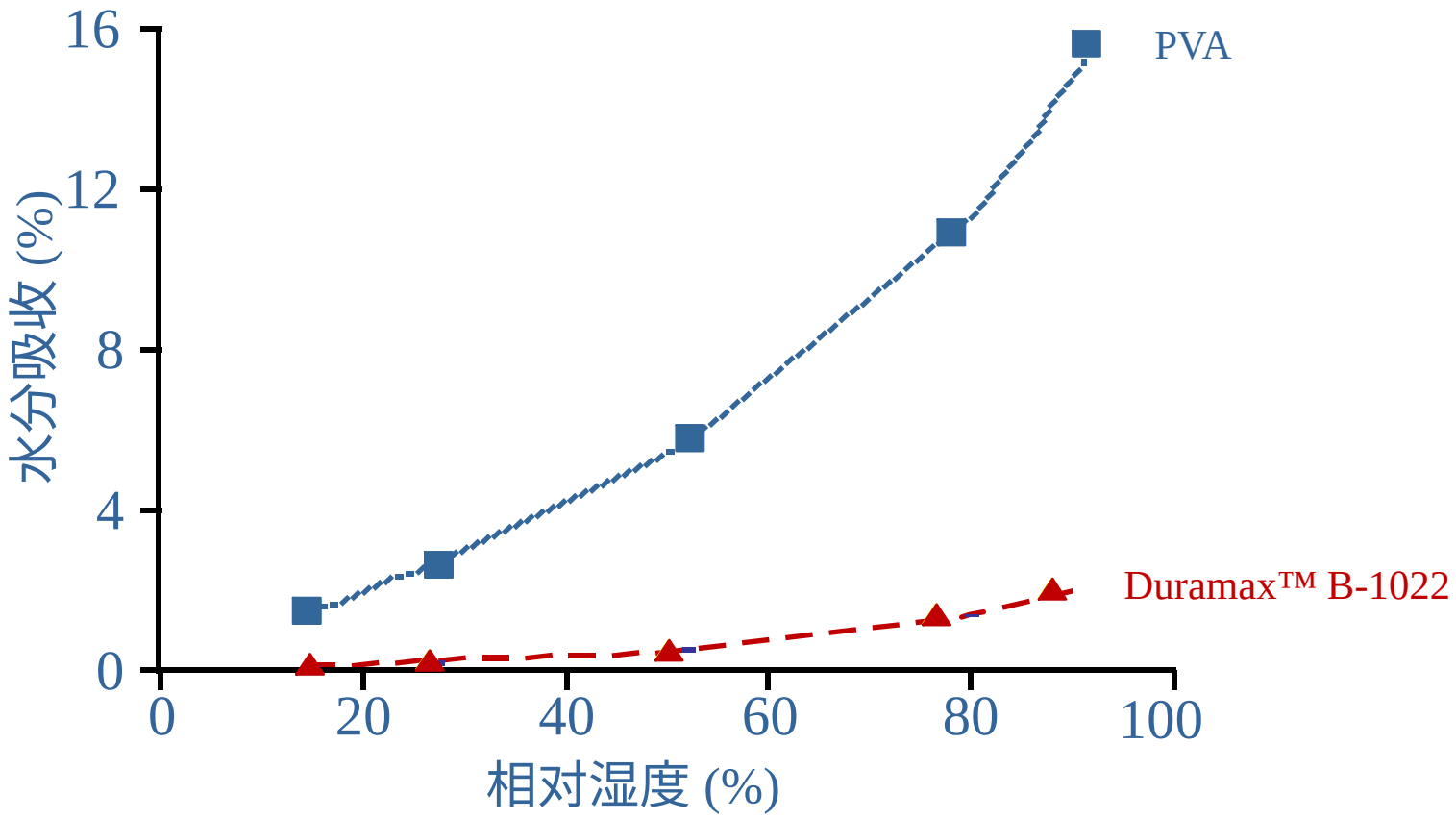
*1% 粘结剂，0.4% Duramax™ D-3001 分散剂

Duramax™ 粘结剂能够在提高浆料固含量的同时保持低粘度



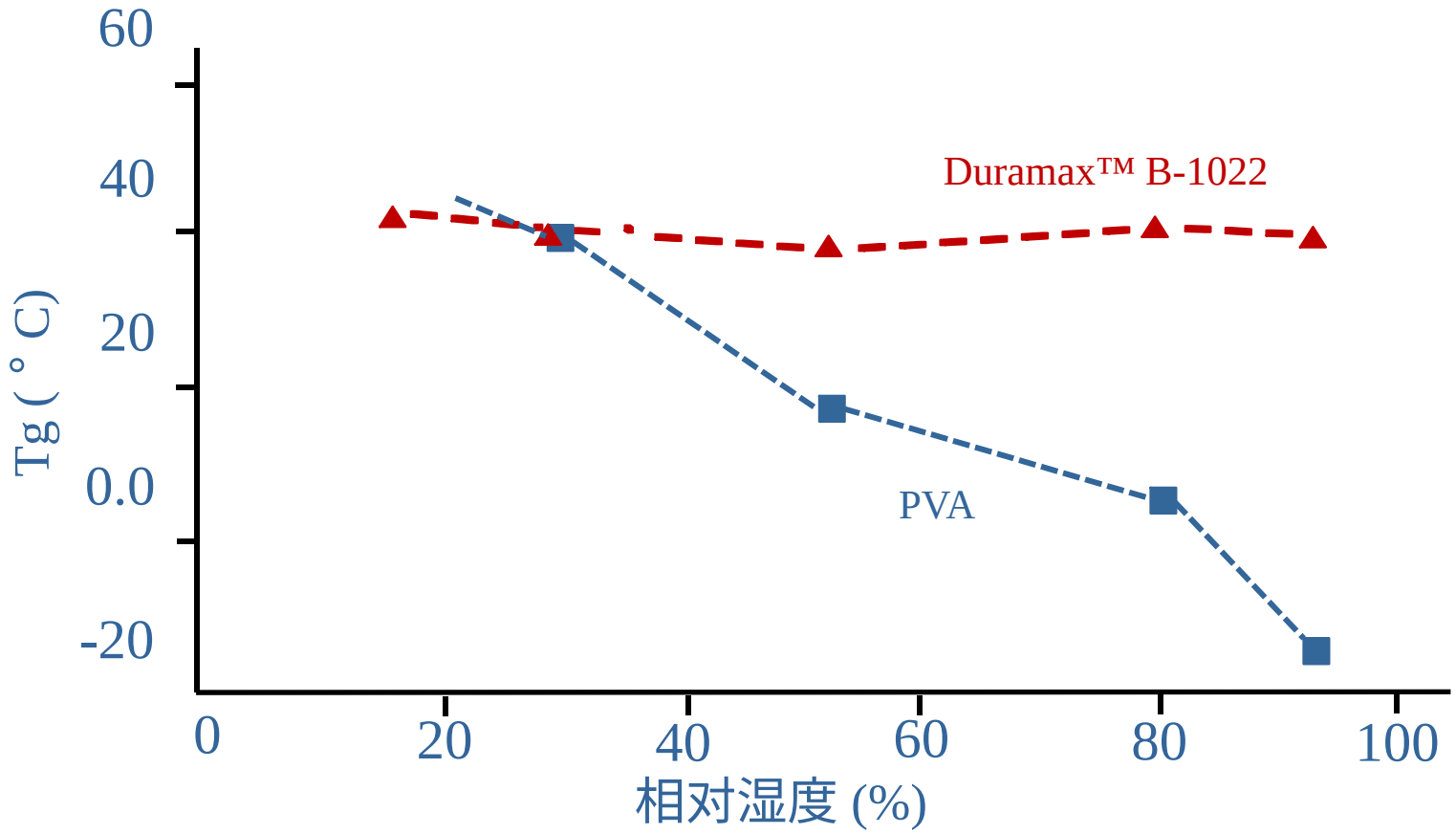
*5% 粘结剂

Duramax™ 粘结剂能够明显降低水分的吸收



* data from neat polymer 使用单一聚合物测试结果

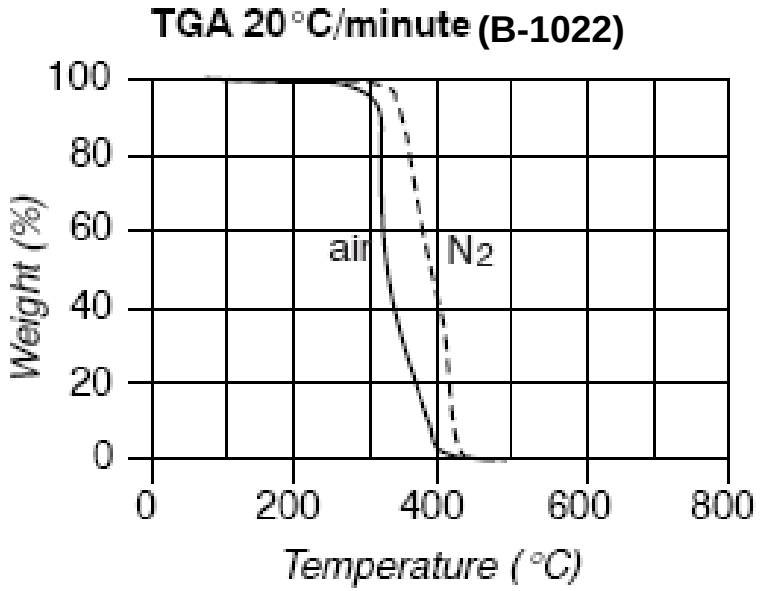
Duramax™ 粘结剂在不同湿度下保持稳定的玻璃化温度

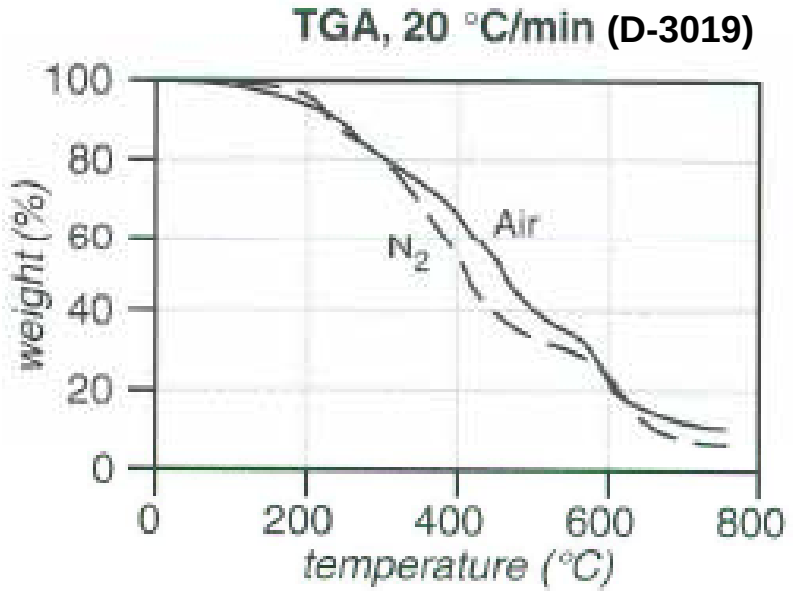


* data from neat polymer 使用单一聚合物测试结果

Duramax™ 粘结剂的燃烧残留少

Binder 粘结剂	Residue (% N2) N2中燃烧残留	Residue (% air) 空气中燃烧残留
Duramax™ B-1022	2.3	0.4
PVA	4.0	0.4



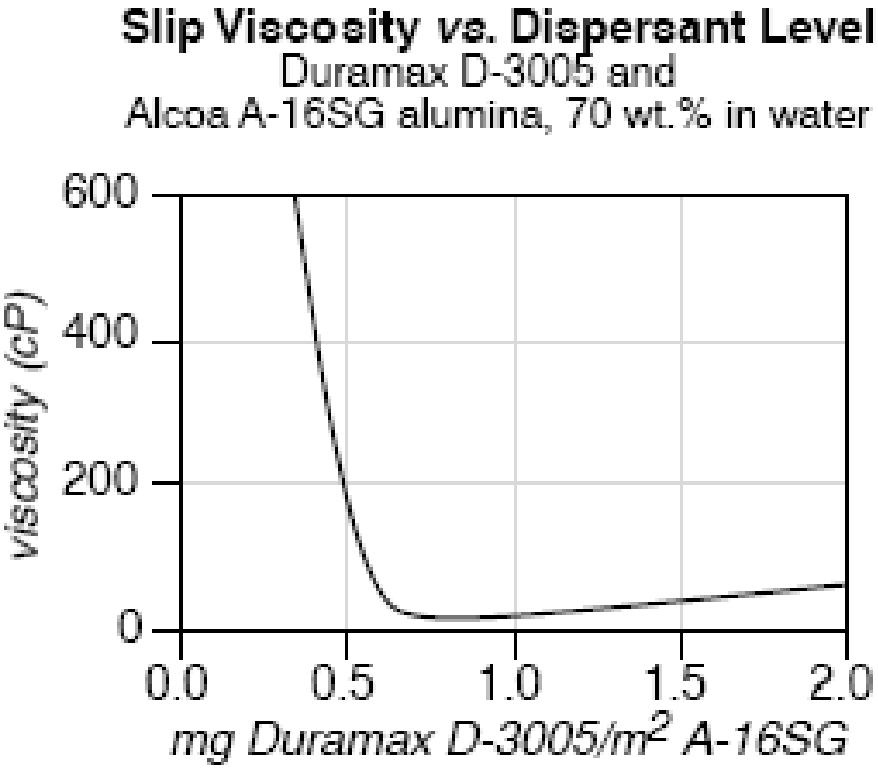


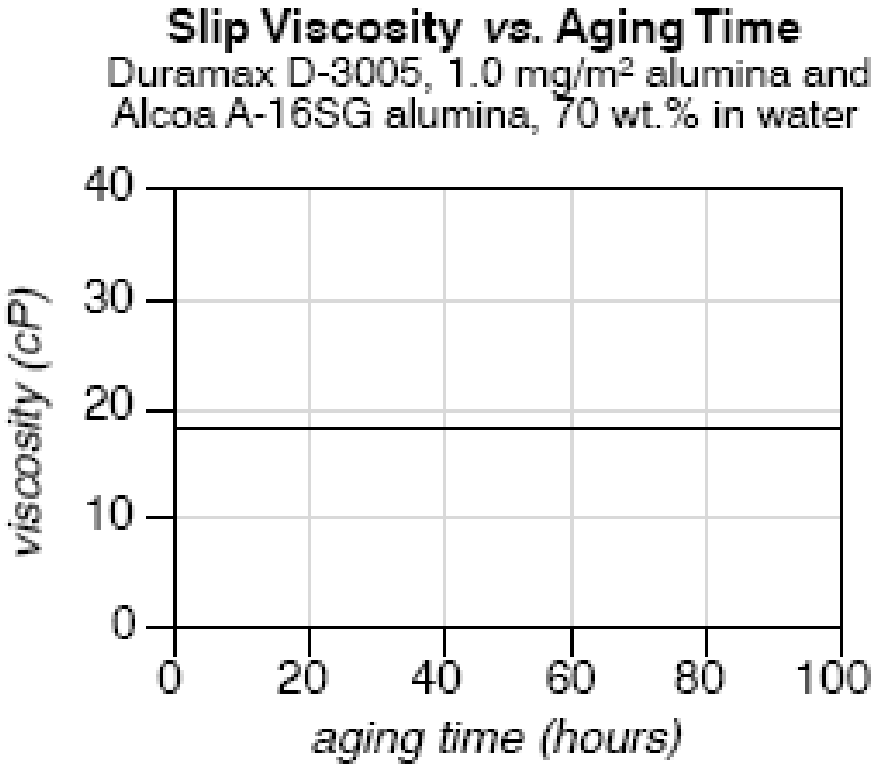
应用实例：氧化铝陶瓷造粒及性能表征

- Slurry prepared by charging a jar mill with: 使用研磨机制备浆料（加入分散剂）
  - Alumina + Dispersant (0.3% on alumina) + DI water to bring slurry solids to 60 - 65%
- The mixture is milled for 20 - 40 minutes, then decanted.
- Binder (1-4% on alumina) is added with stirring. 搅拌过程中加入粘结剂
- Slurry is spray dried 喷雾干燥
  - Inlet temperature about 240^{o}C; Outlet temperature about 130^{o}C
  - Granule size about 10µm.

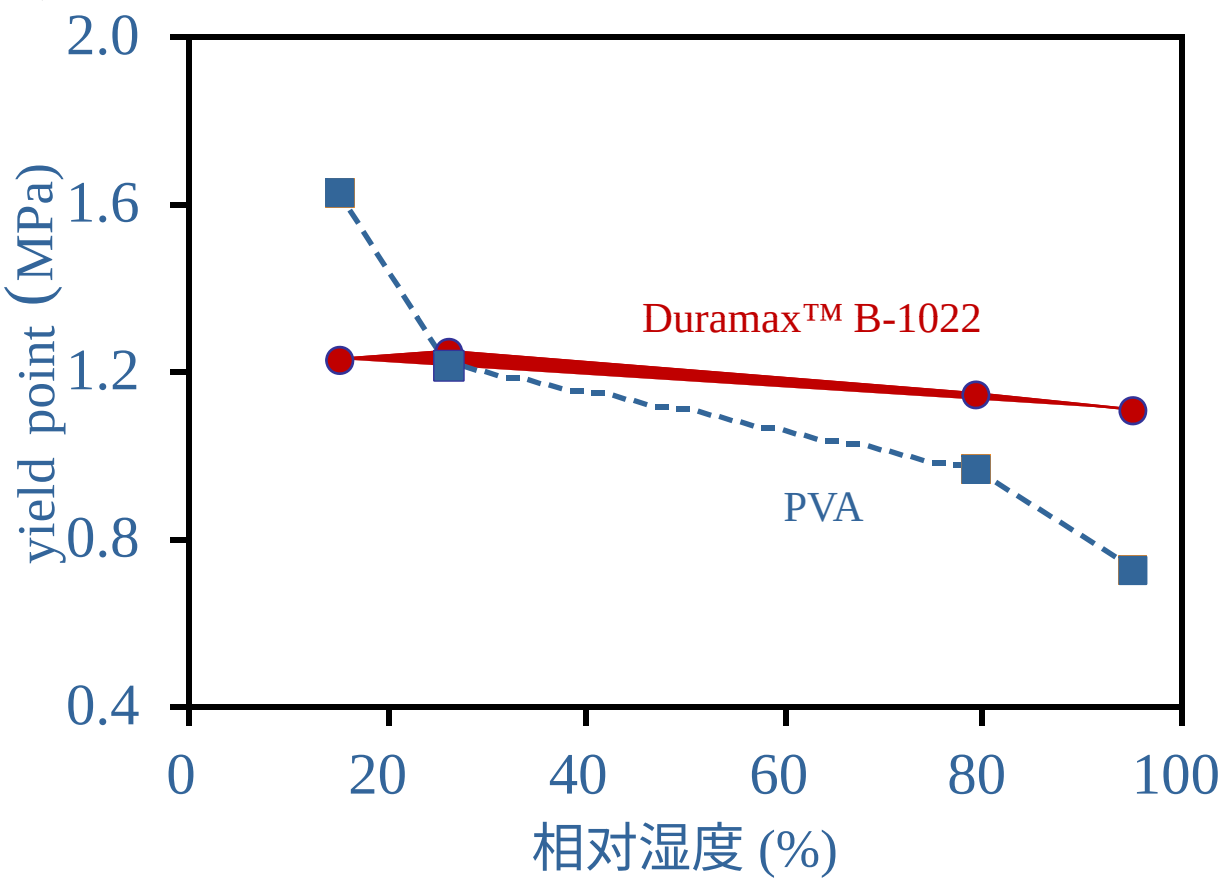
- Sample is pressed in a 12.7mm diameter cylindral uniaxial die at 35–70MPa for 15s.
- Sample weight is 1.0g giving pellets with a diameter / height ratio of approx. 4.
- The following characteristics are measured: 性能表征
  - **生坯密度 Green Density** : Characterize the compaction. Calculated from the weight and dimensions of a minimum of 4 pellets.
  - **生坯强度 Green Strength** : Characterize the resistance to fracture. Measured by diametrical compression. Samples are compressed at a loading rate of 0.13 mm per min.

Duramax™分散剂添加量和老化时间与体系粘度的关系



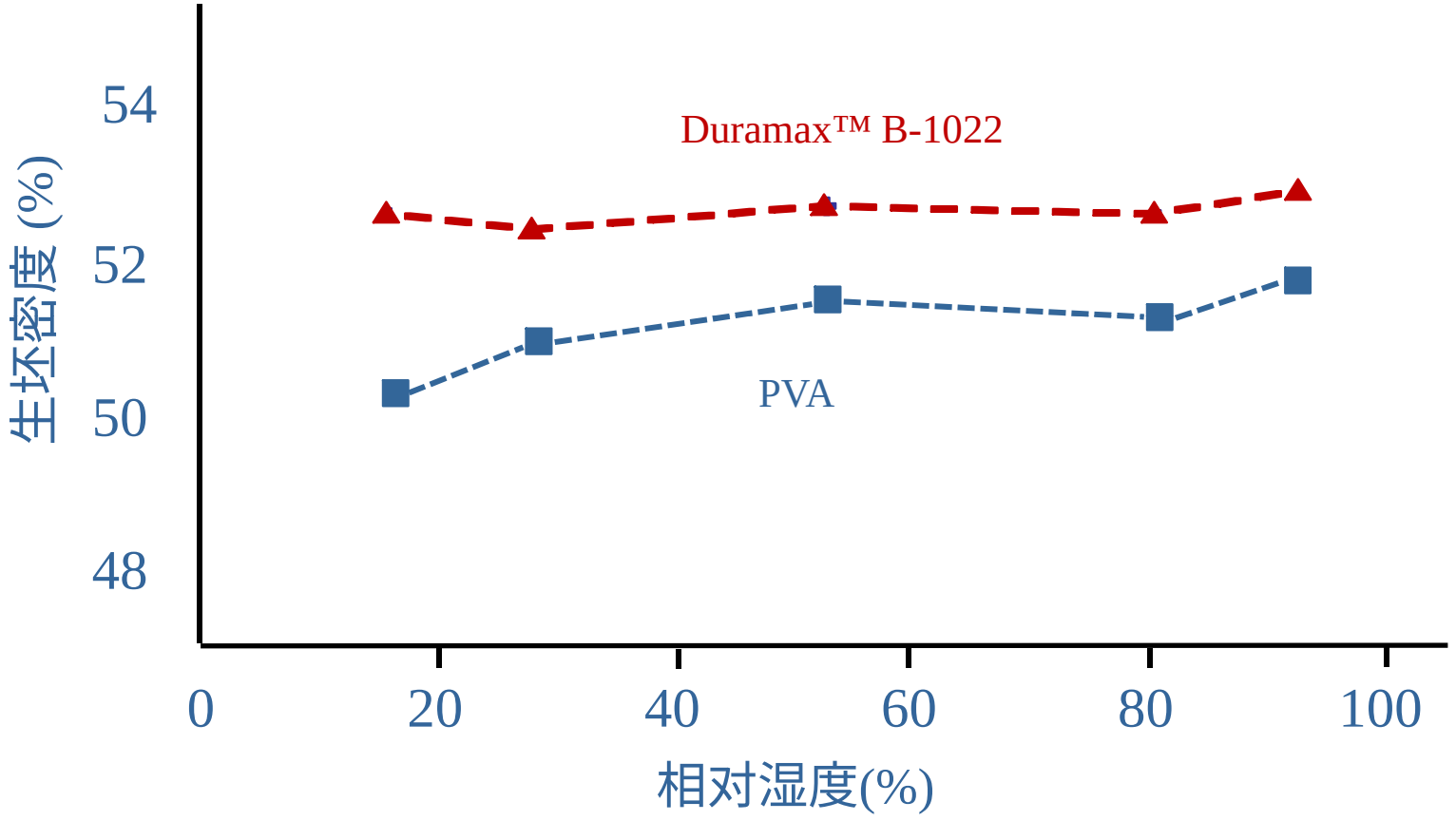


湿度对颗粒硬度的影响



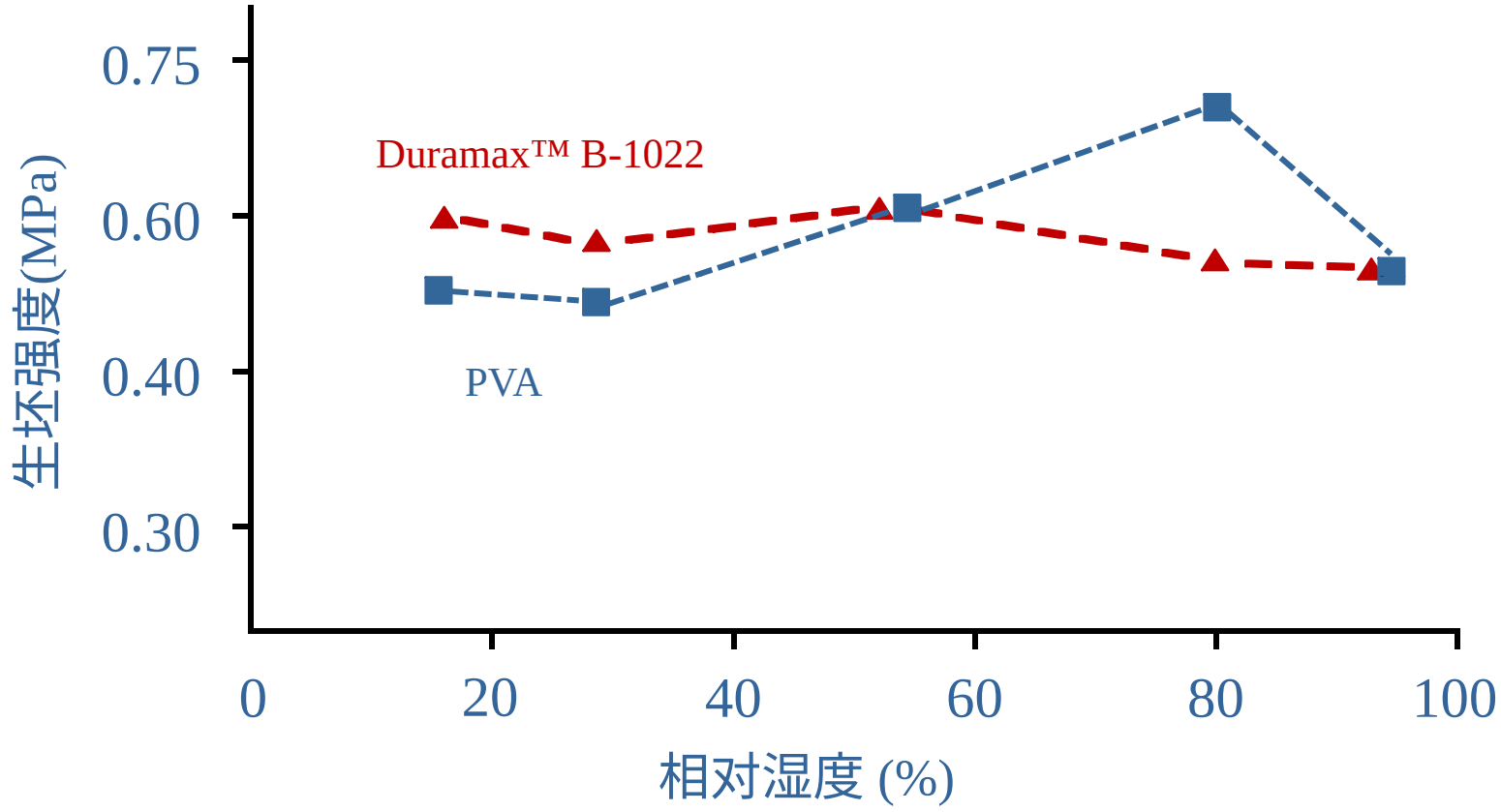
* data from alumina 使用氧化铝陶瓷颗粒测试结果

湿度对生坯密度的影响



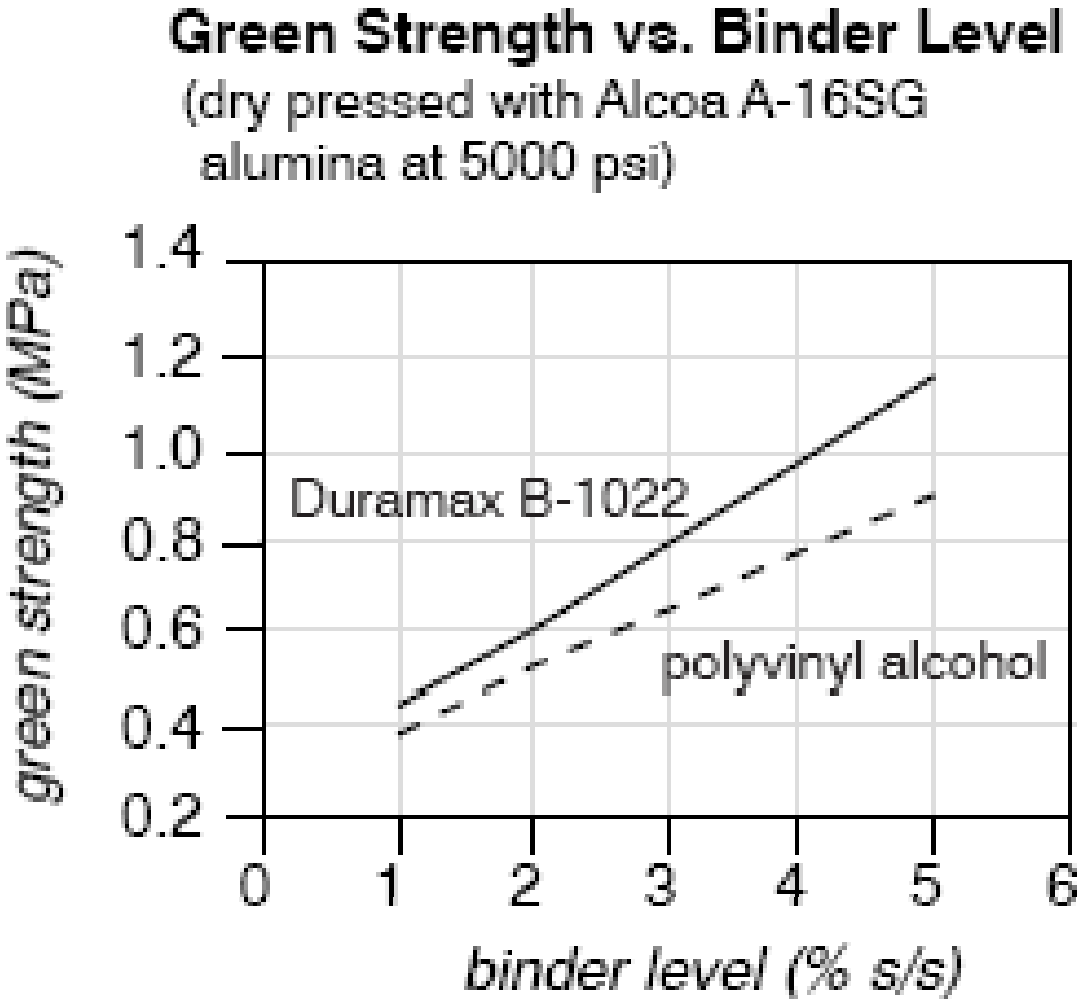
* data from alumina 使用氧化铝陶瓷生坯测试结果

湿度对生坯强度的影响



* data from alumina 使用氧化铝陶瓷生坯测试结果

粘结剂添加量对生坯强度的影响



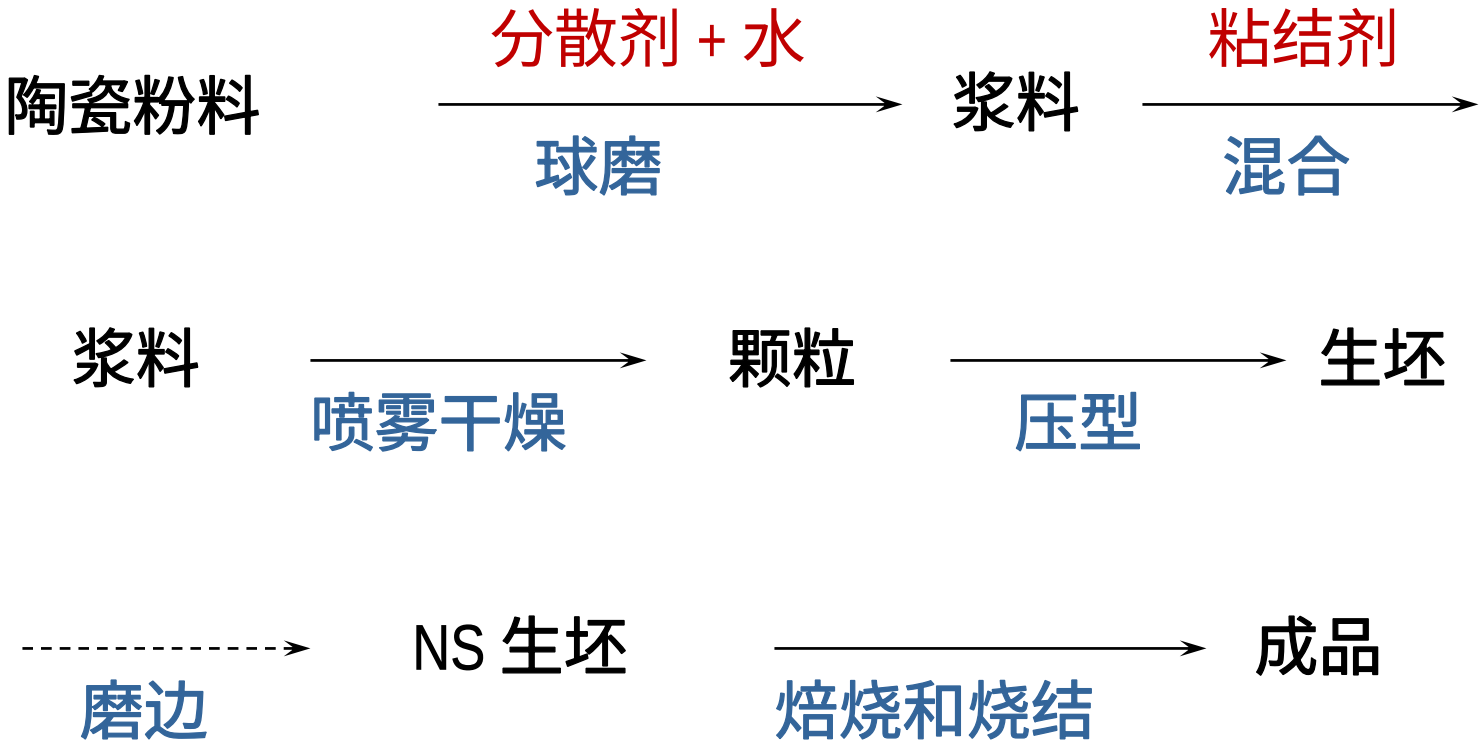
使用Duramax™ 粘结剂和分散剂的产品优势

Properties	Benefits
Low viscosity 低粘度	High slurry solids 高浆料固含量 High drier throughput 高生产效率
No pre-dissolution required 无需预溶解	Few process steps 减少操作步骤
Single binder 单一粘结剂	Low inventory 减少库存清单
High green strength 高生坯强度	Low use level 低用量
Insensitive to moisture variation 对湿度变化不敏感	Wide process latitude 工艺自由度广 Consistency 产品质量一致性
Smooth surface finish 表面光滑	High-quality products 产品质量高
Clean burnout 燃烧残留少	High quality products 产品质量高 No defect 产品无缺陷

Duramax™ 粘结剂和分散剂作为陶瓷添加剂

- Dry Pressing: 干压成型
  - Tableware, Tiles, Artificial Marble, Ferrites, Technical Ceramics
    餐具、瓷砖、人造大理石、铁氧体、技术陶瓷
- Semi-Dry Pressing: 半干压成型
  - Refractory products, Grinding wheels 耐火材料、砂轮
- Plastic Deformation Forming: 塑性形变
  - Hollow Ware, Pottery, Electrical Porcelain Parts
    空心器具、陶器、电子陶瓷元件
- Tape Casting and Roll Pressing: 流延成型和滚压
  - Multi-layer Capacitors, Electronic Substrates 多层电容器、电子基片
- Slip Casting: 注浆成型
  - Sanitary ware 卫生器具

典型的干压工艺流程



Duramax™ 产品用于干压工艺

分散剂 (反絮凝剂、悬浮剂)

Duramax	Mw	pH	Counter ion	Solids (%)	Visco. (mPa.s)	Residue (%, air)	Application
D-3001	4500	7.0	Na	45	600	8.0	Tiles, low end technical
D-3005	2500	6.5	NH4	35	< 100	2.7	General purpose
D-3019	2300	7.0	NH4	50	500	2.6	General purpose

粘结剂

Duramax	Solids (%)	pH	Tg (°C)	Residue (%, air)	Application
B-1000	55	9.4	-26	0.40	Dry Pressing – Jiggering – Thick Tape
B-1022	45	7.5	39	0.40	Dry Pressing - Jiggering

工艺单元1：研磨过程

- **Function 功能**
  - Break down aggregated ceramics to its primary particle size

    将陶瓷颗粒聚集体破坏，减小颗粒粒径
- **Recommended Duramax™ Dispersants 推荐分散剂**
  - **D-3001**
  - **D-3005 / D-3019 / D-3021** if sodium is a concern 不含钠离子
- **Advantages of Duramax™ Dispersants 分散剂优势**
  - **D-3005** high efficiency & no slip aging 高效、无老化现象
  - **D-3019**
  - **D-3021** lowest sodium (18 ppm) dispersant available in market

工艺单元2：混合过程

- **Function 功能**
  - Mix binders with slurry. Always add Duramax™ by mixing, not by ball milling! 在浆料中加入粘结剂，建议使用混合设备而不是球磨设备。
- **Recommended Duramax™ Binders 推荐粘结剂**
  - **B-1022** primary binder to recommend
  - **B-1000** if **B-1022** alone is too hard to press, blend **B-1000** w/ **B-1022**
- **Advantages of Duramax™ 粘结剂优势**
  - Easy of use (dissolving PVA is time consuming & costly)

    直接添加，容易使用，不需预溶解
  - High solids & low viscosity allow high ceramic loading in slurry (PVA tends to give high viscosity or low ceramic loading)

    高固含低粘度，提高浆料的固含量，从而提高生产效率

工艺单元3：喷雾干燥过程

- **Function 功能**
  - Dry slurry into ceramic granules 浆料制备陶瓷颗粒

- **Advantage of Duramax™ 优势**
  - Granules insensitive to moisture, assuring quality consistency (granules from PVA changes with moisture)
    粒子对湿度的变化不敏感，确保产品质量的一致性

工艺单元4：压型过程

- **Function 功能**
  - Press ceramic granules into green bodies with desired density and strength

    压制陶瓷颗粒为生坯，并具有理想的密度和强度
- **Advantages of Duramax™ 优势**
  - Insensitive to moisture, consistent green density and strength (density and strength of PVA vary significantly with moisture)

    对湿度变化不敏感，保持生坯密度和强度的一致性
  - Higher green density and comparable green strength

    更高的生坯密度和生坯强度

工艺单元5：焙烧和烧结过程

- **Function 功能**
  - Remove organic additives and crystallize ceramics
    去除有机添加剂
- **Advantage of Duramax™ 优势**
  - Clean burnout (PVA has higher residue in N_2)
    更少的燃烧残留

性能优势：Duramax™ vs. PVA

- Insensitive to ambient humidity, assuring production consistency.
  不受环境湿度影响，确保产品质量的一致性。
- High green density, and comparable green strength (strength increases when used in combination with acrylic dispersants).
  粘结剂与分散剂一起使用，能够提高生坯的密度和强度。
- Easy of use.
  使用方便。
- Low viscosity, allowing high solids loading of ceramics.
  浆料粘度低，能够增加浆料的固含量，从而提高生产效率。
- Clean burnout.
  燃烧残留低。

应用指南

Application	Process	Dispersants	Dispersant Dosage	Binders	Binder Dosage
Tableware 餐具陶瓷	Dry Pressing 干压成型	D-3005/D-3001	0.08 – 0.15	B-1022/B-1000/B1007	1.0 – 1.5
Tableware 餐具陶瓷	Jiggering 旋坯法	D-3005/D-3001	0.08 – 0.15	B-1000/B-1022/B-1080	0.8 – 1.2
Refractory 耐火陶瓷	Bricks 砖	D-3008		B-1051/B-1043/B-1033	0.5 – 1.0
Refractory 耐火陶瓷	Monolithics 单片	D-3005/D-3019		B-1000/B-1022	
Pressing 干压成型	Artif. Marble 人造大理石	D-3005/D-3019	0.08 – 0.15	B-1000/B-1022	1.0 – 1.5
Pressing 干压成型	Ferrites 铁氧体	D-3005/D-3019 /D-3021	0.3 – 0.5	B-1022/B-1000	1.5 – 3.0
Tape Casting 流延成型	Thick Tape 厚膜	D-3021/D-3019	0.5 – 1.0	B-1070/B/1080 (or B-1002/B-1014)	8.0 – 12.0
Tape casting 流延成型	Thin Tape 薄膜	D-3021/D-3019	0.5 – 1.0	B-1070/B-1080	8.0 – 12.0

谢谢！