Ecoflex® 500
Next generation Ecoflex Mounting Mat

A highly resilient, non-intumescent, polycrystalline fiber mat with improved substrate retention capability

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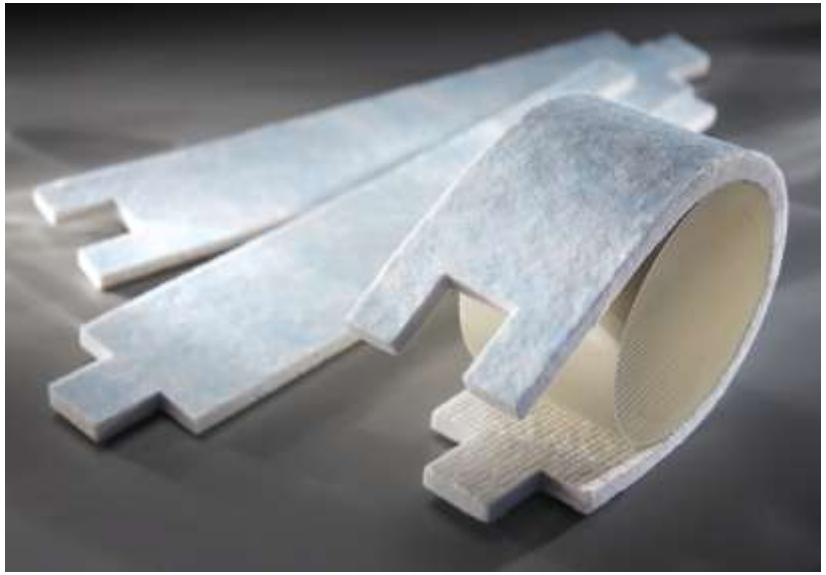


Ecoflex 500 Product Features, Applications, Status

Features

- Latest generation PCW fiber, highly resilient, **high RGE capable**
- Large diameter “Fat” fiber – less than 0.1 wt% WHO fiber;
- Low binder content of 5.5%
- Excellent erosion resistance
- Up to 20% more mat retention pressure vs other Ecoflex mats
- Best performing Ecoflex mat in high gap expansion applications

New Fiber!

➢ **Delivers a better value proposition of performance and price vs other Ecoflex mats**

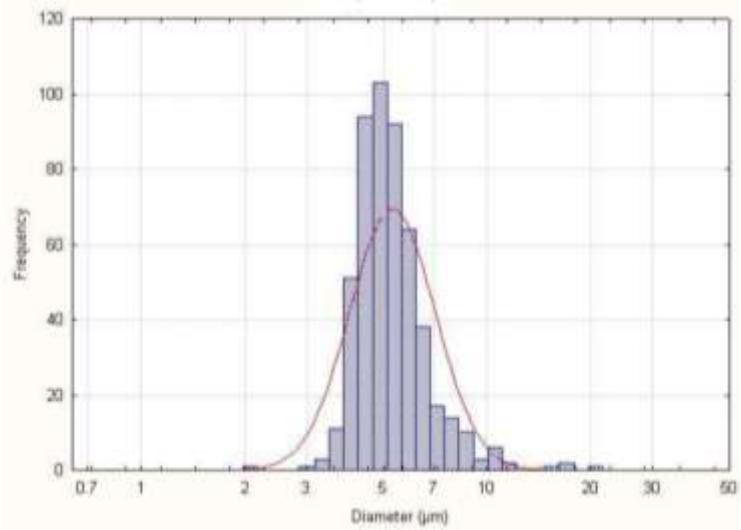
Applications

- All gasoline and diesel applications
  – CC, UF, GPF/OPF, DOC, SCT, DPF
- Mat/monolith temperatures from ambient up to 1100^{o} C
- Large and small gaps

Status

- Fiber and mounting mat made by Unifrax in the U.K.
- **Commercial Launch October 2018**
- **Runnning on Programs in India and China**

XFIL® PCW Fiber Diameter Analysis



Average Fiber Diameter
5.5 µm

Fraunhofer ITEM Analysis of length weighted geometric mean diameter Page 3

The mass fraction of WHO fiber is 0.041 % of the total fiber mass

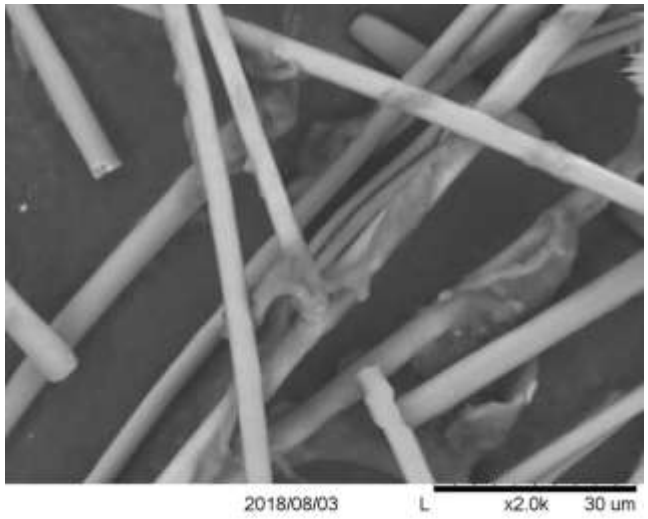
	Fiber sample sent December 16, 2013
Number of analysed fibers	515
WHO fibers	3
Mass% of WHO fibers	0.041
WHO fibers/mg	3296

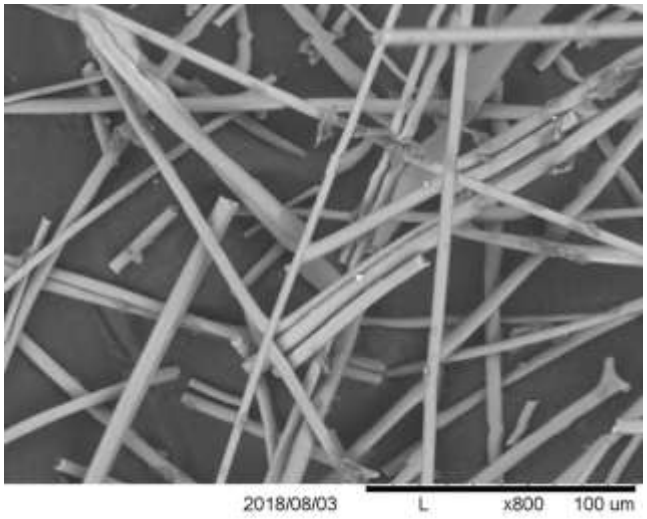
XFIL PCW fibers were analyzed for WHO fiber content at the Fraunhofer Institute

Result: the mass fraction of WHO fibers was less than 0.1%

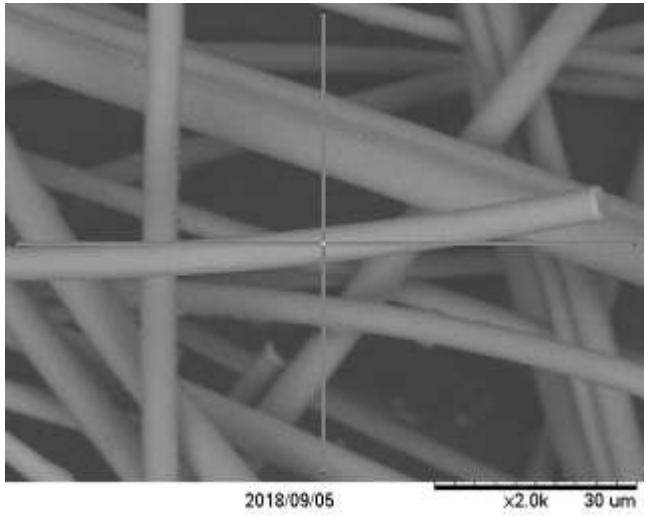
SEM Micrographs

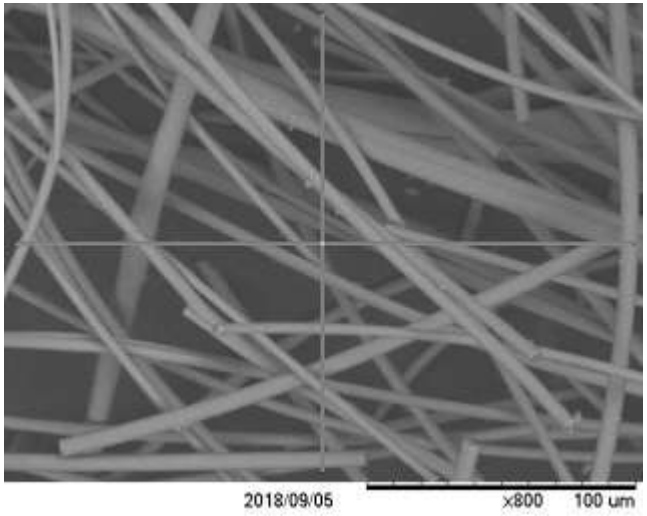
With Binder:





Without Binder:





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Ecoflex 500 Production

- XFIL fiber production : Widnes (UK) fiber plant
- Mat production: Holywell, UK serial production facility
  - Same Ecoflex process used to manufacture Ecoflex 200(LB) and Ecoflex 200M 2HF-D
- Process: sheets batch formed, dried in heated press, and die-cut
- Top surface of the mat includes an optional light-blue 18 gsm fleece which is oriented towards the steel shell

Material Properties

Ecoflex 500 Material Properties

Fiber type:	Polycrystalline, mullite
Ave. fiber diameter:	5.5 µm
WHO fiber content:	Less than 0.1%
Loss on Ignition:	3.0 – 7.0%
GBD range:	0.30 – 0.55 g/cm^3

High average fiber diameter
Low binder content
Flexible basis weight range

Basis Weight, fiber only (g/m^2)	Basis Weight, Including binder (g/m^2)	BW Tolerance	Nominal Thickness (mm)
1200	1266	+/- 10%	8.6
1600	1688		11.3
2000	2005		14.0
2400	2321		16.7

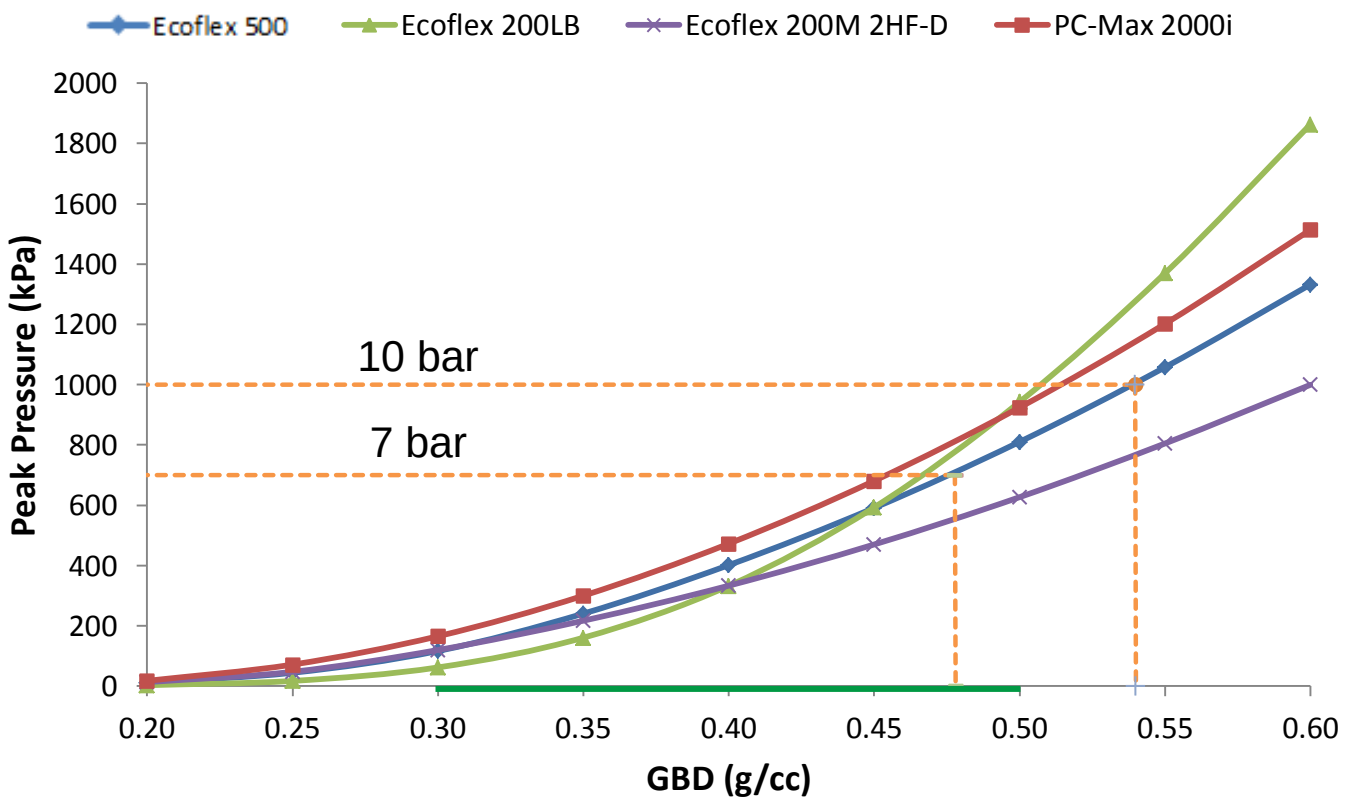
- **Product supplied with low organic scrim (adds 18 g/m^2)**
- **Additional basis weights from 1050 g/m^2 – 2400 g/m^2 on request**

Material Performance

Cold Compression: Peak Pressure

MTS Machine: 25 mm/min
Averaged Data, n=3

Ecoflex 500 vs. Ecoflex 200LB, Ecoflex 200M 2HF-D and PC-Max 2000i



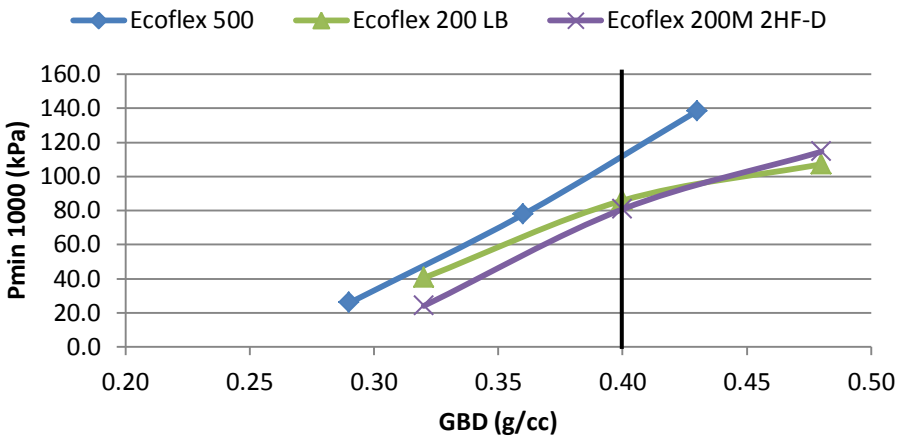
- Similar compression profile to current Ecoflex mounting mats
- Low peak pressures across a broad GBD range allows for a wide operating window with very low substrate breakage risk

1000 Cycle, Aged Mat Pressure Testing
Isothermal Temperature Conditions

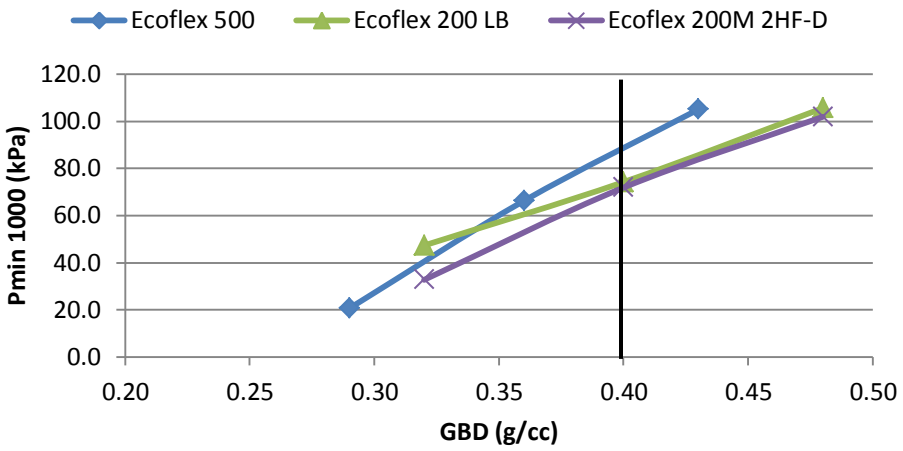
MTS Machine: 10 mm/min
n = 1

Ecoflex 500 compared to Ecoflex 200LB and Ecoflex 200M 2HF-D

4% RGE - 300 °C



8% RGE - 600 °C



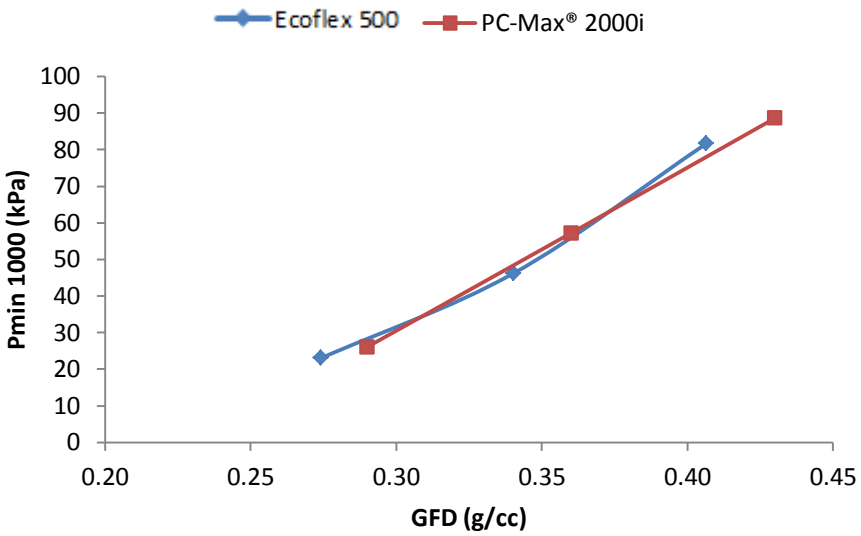
- Excellent pressure performance across a wide GBD range for Diesel Applications versus current widely used Ecoflex product

1000 Cycle, Aged Mat Pressure Testing
Isothermal Temperature Conditions, Extreme Gap Expansion

MTS Machine: 10 mm/min
n = 1

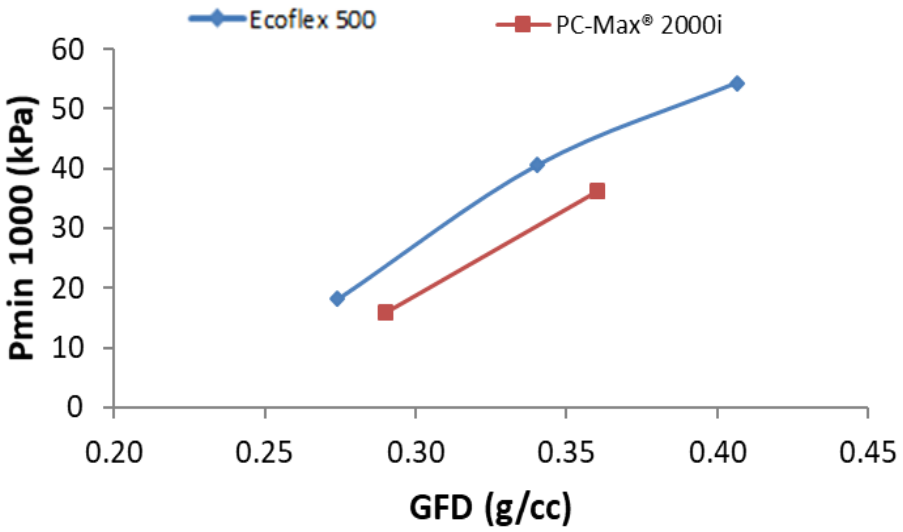
Ecoflex 500 compared to PC-Max 2000i needled Mat

12% RGE – 600 °C



Comparable to Needled Mat for High RGE Diesel applications

16% RGE – 600 °C



High RGE → Best Performing!

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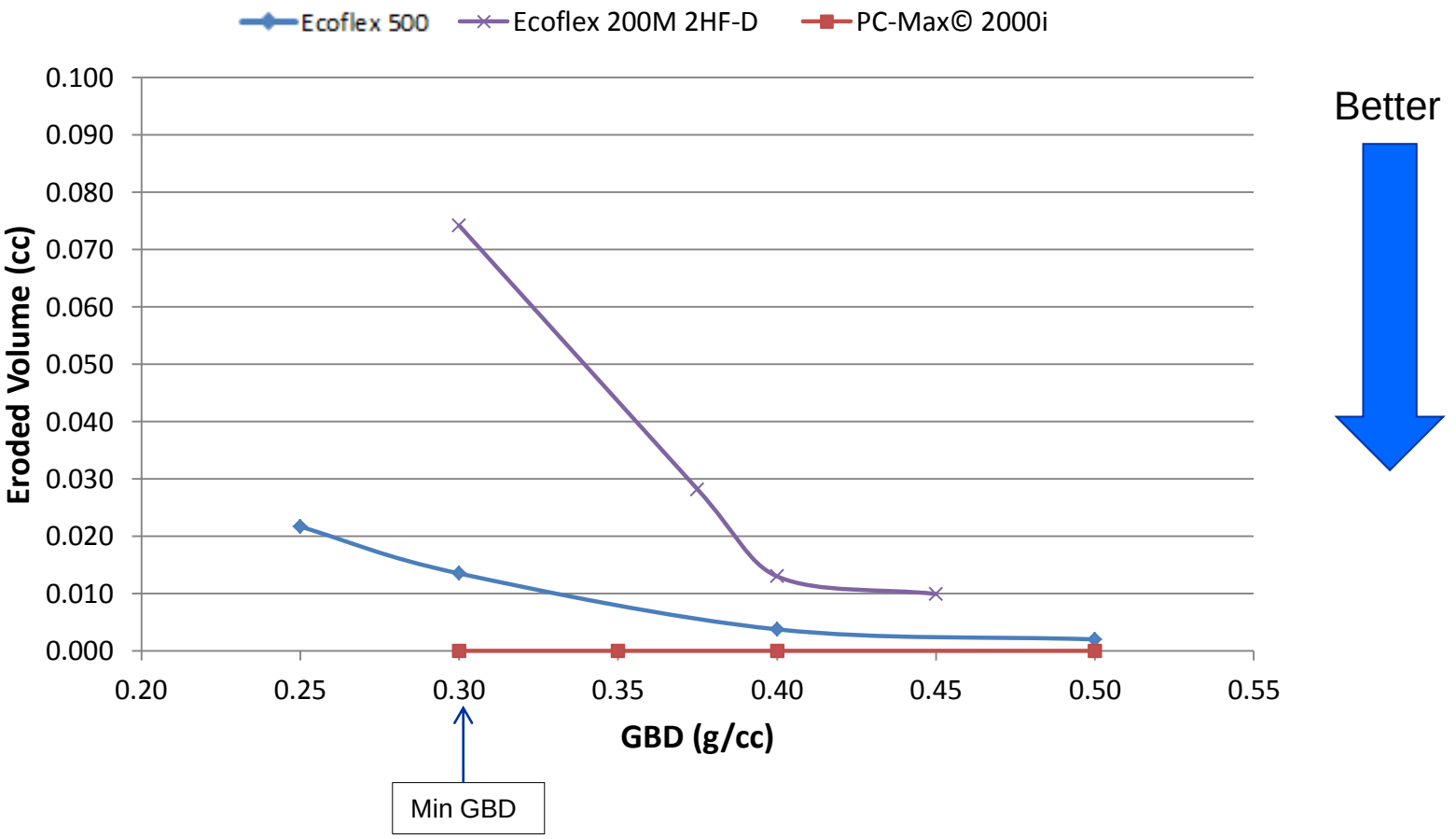
Erosion Durability

Erosion Tester (US): 1.6 bar, 50 mins
n ≥ 3



Hot Shake Testing

- Protocol:
  - Temperature & Air Flow:
    - Temperature Profile: 950 – 350 °C cycling
    - Inlet air flowrate: 130 SCFM
  - Step Test Vibration Profile:
    - 45° shake angle
  - Substrate: coated cordierite (2.28” x 4.66”, L/D ≈ 0.49)

Vibration Step Table

Step	*Description*	*G (rms)*	*Hours to Complete*
1	Cold Vibration	20	1
2	Heat soak	0	1
3	Hot Vibration	15	3
4	Hot Vibration	20	3
5	Hot Vibration	25	3
6	Hot Vibration	30	3
7	Hot Vibration	35	3
8	Hot Vibration	40	3
9	Hot Vibration	45	3
10	Hot Vibration	50	3
11	Hot Vibration	55	3
12	Hot Vibration	60	3

Hot Shake Test Results

Test Protocol

- Inlet gas temperature = 950 °C
- Step 1: 20 g_{rms} at room temperature
- Step 2: 15 g_{rms} at 950 °C
- Step 3-n: increase by 5 g_{rms} each step
- 3 hrs per step
- 4 air quench cycles per hour

Substrate 4.66” ø x 2.28”

Material	Lot	GBD	Failure Step	G-Load
Ecoflex 500	A	0.38	10	55
	B		10	55
	A	0.45	11	60
	B		11	60
Competitor Wet Laid	A	0.38	10	55
		0.45	10	55
Ecoflex 200LB	A	0.38	9	50
Ecoflex 200M 2HF-D	A	0.38	10	55
		0.45	10	55
PC-Max 2000i	A	0.40	11	60

In Summary...

Best in class holding performance for non-needled PCW fiber mats at equivalent mount densities

- ✓ Ideal for large (>16%) RGEs
- ✓ Comparable performance to PC-Max 2000i

✓ Large average fiber diameter, (< 0.1% WHO fiber content)

✓ Low organic content

✓ Valid for all mat/monolith applications from ambient to 1100° C

✓ Compatible with all substrate types including high porosity ultra-thin wall

➢ Commercial now...

Ecoflex 500 delivers a better value proposition of Performance and Price!

Thank you!