

Flint Creek Resources, Inc.

Glass Polish Upcycling



FCR

May 2016

by Mark Mayton

Gorham, New York



Why do we want to upcycle?

- Reduce polishing compound costs by 20 to 40%
- Improve polishing quality
- Create a stable supply of polishing compounds
- Preserve valuable rare earth resources
- Reduce waste materials in sewers and local landfills
- Create custom formulated compounds
- Become our own best raw material supplier
- Because it is the right thing to do for you, me and everyone

Why Does Glass Polish Upcycling Work?

- Cerium oxide particles do not wear out
- Cerium oxide does not chemically react with the glass, but promotes the hydration of the glass surface
- Slurry performance declines because it becomes contaminated with:
 - Glass particles
 - Pad material
 - Carrier material
- Contamination can be removed
- Fine ceria particles are also removed

FCR

380,000 liters of slurry have been upcycled

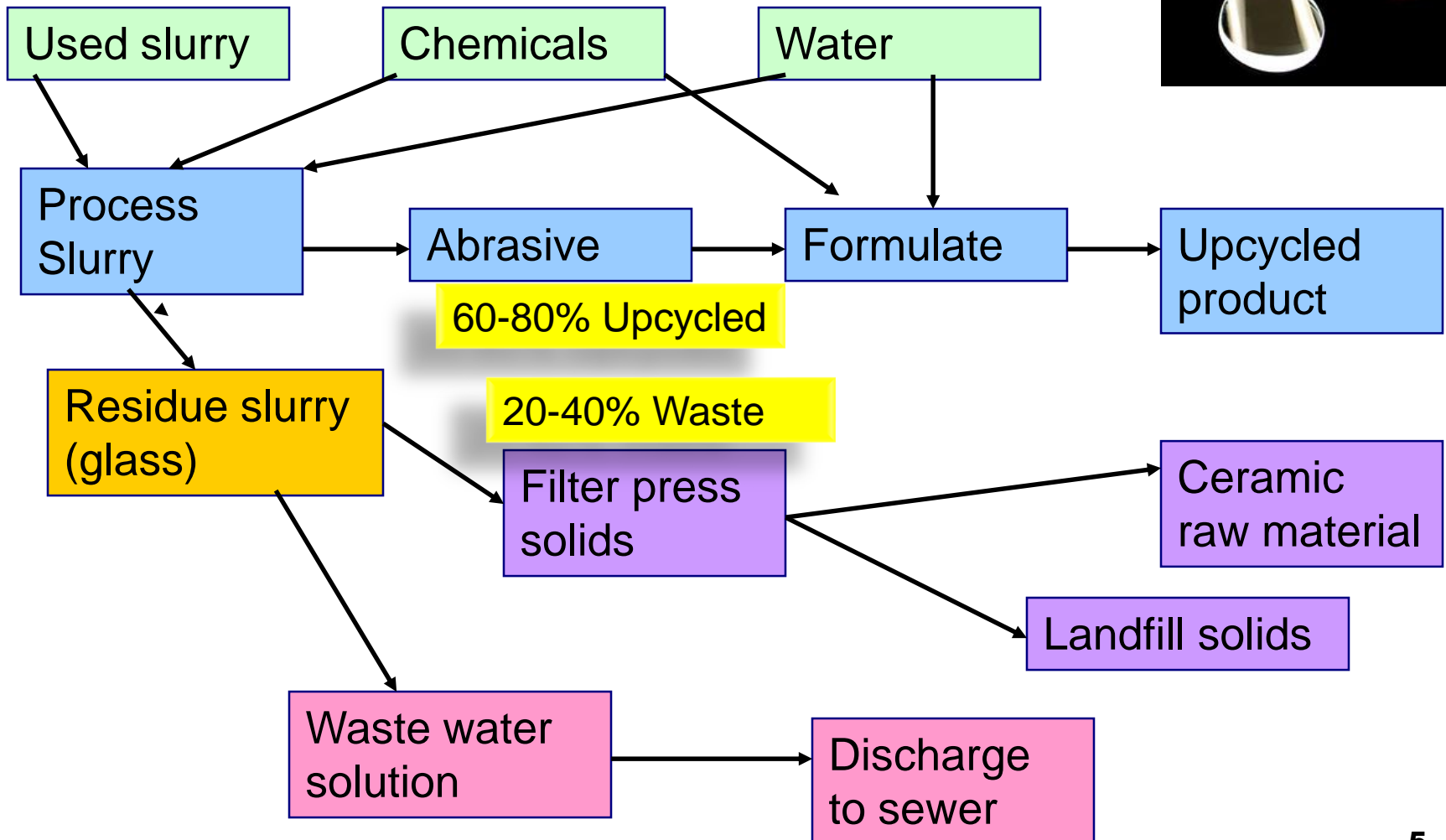
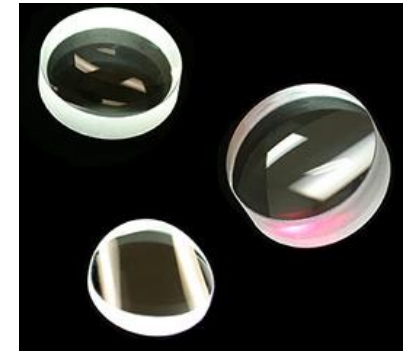
Process Overview

- 1) Recover spent slurry
- 2) Separate cerium oxide from slurry contamination
- 3) Mix in dispersion/suspension additives
- 4) Test
- 5) Use slurry
- 6) Recover spent slurry



Some particles have been upcycled for 5 years

Upcycling Process in the Facility



Customer Data

Surface quality in most cases has improved



Glass	Polish	Peak to Valley	RMS	Ra
Fused silica	Std.	79.2Å	9.2Å	7.3Å
	Upcycled	84.4	8.3	7.4
BK7	Std.	289.0	29.7	23.8
	Upcycled	182.0	21.7	17.3
Borofloat®	Std.	176.0	10.9	8.7
	Upcycled	118.0	10.6	8.4

The glass removal rate says the same with all glass types

Virgin Slurry On BK7

PV 289 Å
 RMS 29.7 Å
 Ra 23.8 Å

zygo Microscope Application

20X Mirau

MEASURE
 Analyze
 Mask Data
 Load Data
 Save Data
 Calibrate
 Home Z
 Home XY

Measure Controls
 Analyze Controls
 Stage Controls
 Focus Controls
 Sequence Controls
 Test+Ref Controls
 Surface/Wavefront
 Surface Profile
 Slope X Map
 Slope Y Map
 Slope Mag Map
 Spectrum Profile
 Environment Test
 Analyze Attr
 Report
 Process
 Units
 Video Monitor

zygo Surface Map

zygo Oblique Plot

PV	288.757	Å
rms	29.675	Å
Ra	23.776	Å
Size X	0.35	mm
Size Y	0.26	mm

Removed: 4th Order
 Trimmed: 0
 Filter High Wavelen: μm
 Filter Low Wavelen: μm

zygo Measure Attributes

Mon Mar 28 09:26:19 2011
 Camera Res: 0.5481 μm
 Virgin Unicer 166
 BK7
 Objective: 20X Mirau
 Subtract Sys Err: On
 Side 1

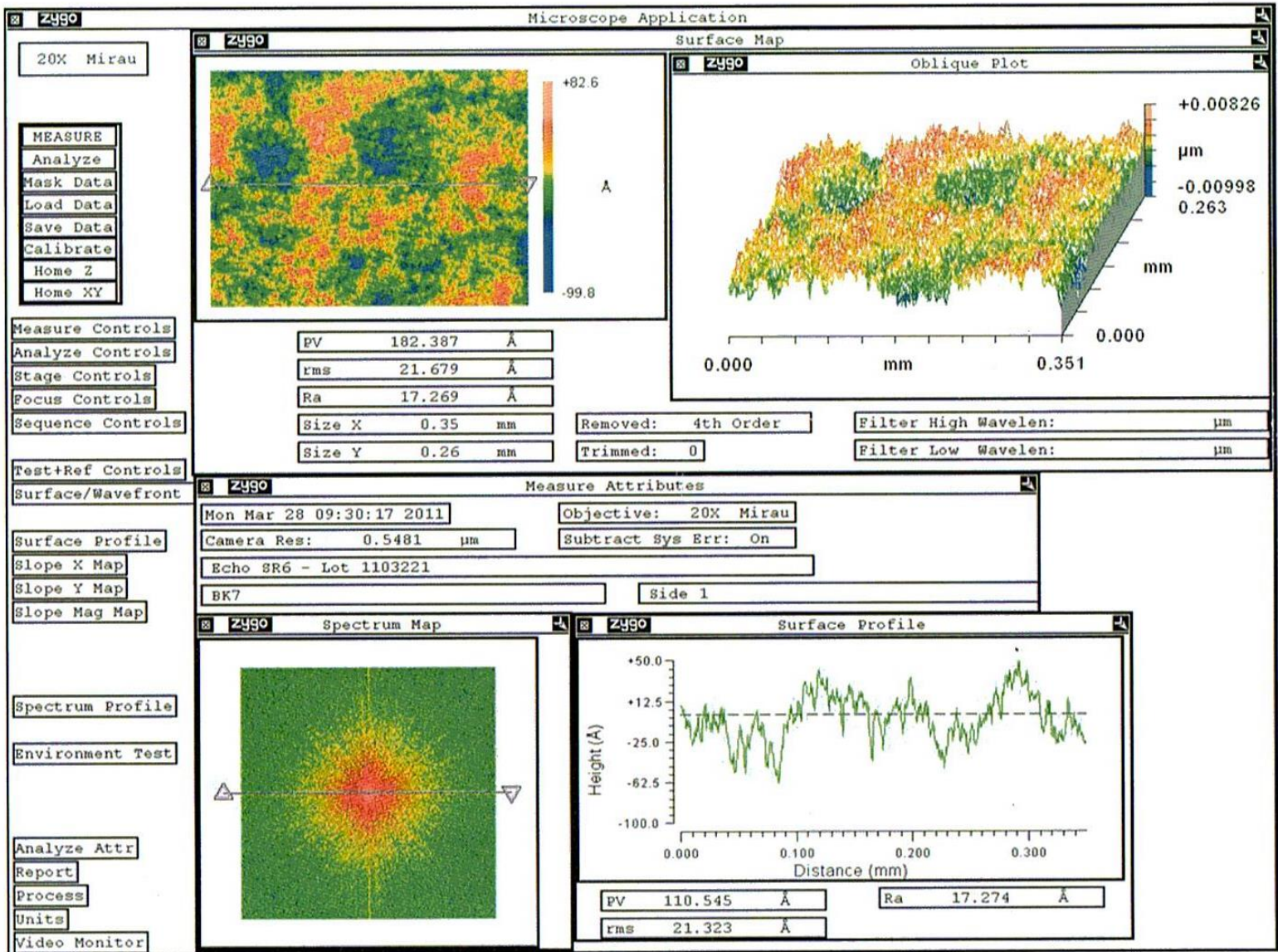
zygo Spectrum Map

zygo Surface Profile

PV	115.068	Å
rms	23.667	Å
Ra	18.927	Å

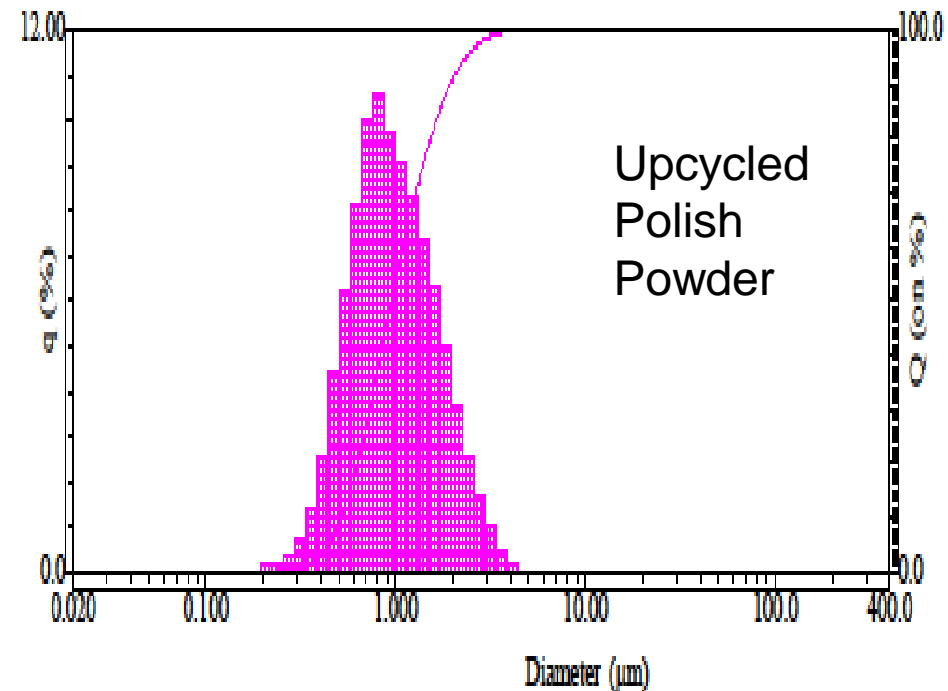
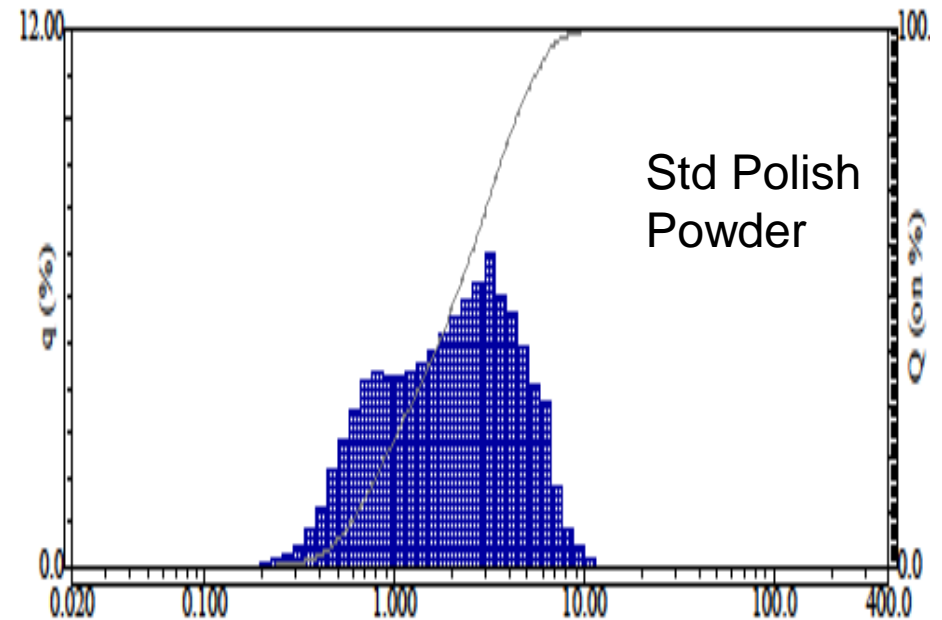
Upcycled Slurry on BK7

PV 182 Å
RMS 21.7 Å
Ra 17.3 Å



Particle Size

- Reduction of particle agglomerate size is likely the reason for better surface quality
- Std powder
 - D3 – 0.44 μ m
 - D50 – 2.1
 - D97 – 6.9
- Upcycled powder
 - D3 – 0.39 μ m
 - D50 – 0.9
 - D97 – 2.7



Process On a Pallet - POP

- In factory upcycling
- Upcycle 60 kgs per day
- Completely automatic
- Pilot test July 2016
- 1.3 x 1.3 meters
- Can be scaled to 1000 kgs/day



First Steps

FCR

1. Supply spent and virgin samples to FCR
 - FCR will upcycle the spent slurry
 - FCR will send polish test results for spent, virgin and upcycled slurry
2. Send larger spent slurry sample to FCR
 - FCR will upcycle spent slurry
 - Spent slurry is returned to customer for in-house testing
3. FCR will supply quote for POP unit