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Zirconolite Binder

Zirconolite is Calcia-Zirconia-Titania (CZT) with theoretical formula $CaZrTi_2O_7$ and is well known as having high capacity to accommodate many lanthanides/actinides to form "Syn-Roc" like phases that can immobilize /stabilize their radioactive forms. Typically, the Zirconolite requires high temperatures to densify /sinter/melt in order to accomplish this stabilization – generally over 1400 C for densification to over 95% as desired for nuclear wasteforms [1, 2].

Zirconolite Binder is a gel-type suspension whereby oxide powders or solutions of lanthanide/actinide compounds can be easily investigated by merely mixing them into the binder. As an example, using Ceria (CeO_2) powder at 40% addition to the binder, a useful coating for metal/ceramic substrates can be made. Additionally, drying the coating followed by grinding and pressing 15 gram 'pucks' in a 1" diameter die to 20,000 psi resulted in 94 to 99% density at 1300 C for 1 hour in air atmosphere.

Zirconolite Binder has a long shelf life of over 12 months and has a moderate pH of 5-6, so should be compatible with many materials as additives for a coating or for making a densified body as described above.

Key Attributes

- Forms very-stable $CaZrTi_2O_7$ compound Zirconolite
- Good suspendability of High-Z oxide 'filler' powders
- Compatible with liquid (dissolved-metal) additives over wide pH range
- Good in all atmospheres with minimal outgassing
- Safe, water-based

Ideal Use

- Testing of loading with High-Z nuclear wasteform materials
- Immobilization/stabilization of materials by sintering
- Densification to over 95% at <=1300 C
- Preparing paintable high-use-temperature coatings of High-Z materials

Use Notes

1. Resuspend if needed.
2. Add refractory 'filler' (<10 µm preferably) at 30 to 50%; or add solution of the metals desired to incorporate into Zirconolite.
3. Mix by shaking or rolling.
4. If coating, apply to substrate, dry, and place into high-temperature use environment.
5. If to be made into a "Syn-Roc" like phase, dry, press into pellet, sinter at 1300 C for ½ hour.

Specifications

Active Ingredient	$CaZrTi_2O_7$
Max Use Temperature with All Atmospheres	Est. >1500 C (>2732 F)
Fired Composition	100% $CaZrTi_2O_7$ [unless High-Z containing oxides/solutions added
Binder Phase	$CaO\text{-}ZrO_2\text{-}TiO_2$
Liquid Carrier	Water
Water Resistance (after drying only)	Low
Hardness	Medium
Ability to Suspend Solids	High
Brookfield Viscosity (cps)	1250-1600 @3/60
Specific Gravity	1.2
Shelf Life (months)	>12
Coating pH	5-6
H-F-R Ratings	1-0-0
Substrate Use	All
% Volatiles	85

Sizes

Zirconolite Binder is a white, gel-like liquid
Standard Size: 1 gallon,1 quart Nalgene containers

Safety Information

- Consult SDS before use.
- Avoid breathing of spray/vapors.
- For Industrial Use only.

References

1. *Y-B Chen, W-C Bao, S-K Sun, L.R. Blackburn, Z-J Wei, W-M Guo, H-T Lin, "Phase and structural evolution of zirconolite ceramics prepared by solid-state reaction sintering," Ceramics Intl., 49, 419-424 (2023).*

2. *L. R. Blackburn, D. J. Bailey, S-K Sun, L. J. Gardner, M. C. Stennett, C. L. Corkhill, and N. C. Hyatt, " Review of zirconolite crystal chemistry and aqueous durability," Adv. Applied Ceramics, 120, 69083 (2021).*

CAUTION: DO NOT CONTACT WET COATINGS WITH MOLTEN METAL.