

Objectives

A good dispersion ensures uniform properties across the product. SI-TUFF™ comes in discrete fiber or microfiber forms. Therefore in a good dispersion the high aspect ratio SI-TUFF™ product is uniformly distributed throughout the material, with no lumping or agglomeration. A coating containing Si-TUFF™ should be smooth and free of visible lumps. A good dispersion also delivers desired performance at the lowest possible loading levels.

Achieving Dispersion

Achieving dispersion involves using the right technique for the following conditions:

- (1) Use of fiber or microfiber;
- (2) Use of water or solvent-based systems (monomer or oligomer based systems act like solvents).
- (3) High or low viscosity systems (lower viscosity is preferred)



There is a big difference between SI-TUFF™ fiber and microfiber, and the dispersion techniques can be quite different as well. The dimensions of each are:

-  Microfiber: 0.65 μm diameter x 12 μm length
-  Fiber: 7.0 μm diameter x 50 μm length

Figure 1 compares the two products.

Processes to Disperse

A wide range of processes can be used to disperse the products. Ball mills with plastic media are viable in lower viscosity systems. If this route is chosen we recommend media 15-30 mm diameter. Under a high viscosity system consider a ball mill with steel media. Three roll mills that have micro-gapping capability are also good. Mechanical high shear mixing and low shear (e.g. simple agitation such as with a Lightning Mixer) can also be used depending on dispersant and viscosity. Most pigment mills are suitable for SI-TUFF™. Finally, ultrasonic dispersion is viable if the solids content is low enough.

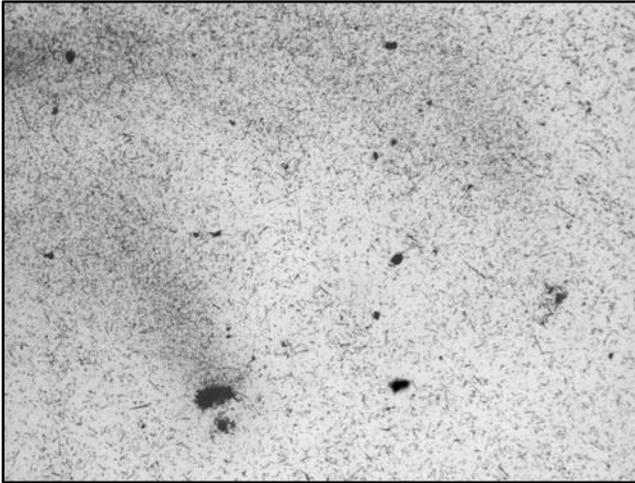
SI-TUFF™ Dispersion Table

The table below provides a grid of recommended approaches under specific conditions.

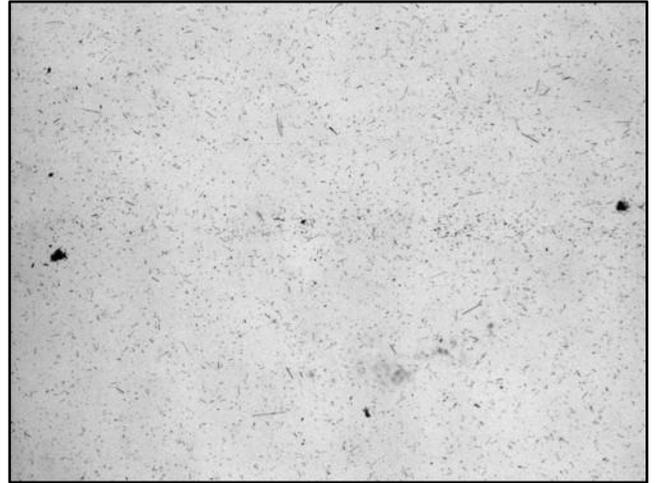
Dispersant	SI-TUFF™ Material	
	Microfiber	Fiber
Aqueous	<ul style="list-style-type: none"> - Under low viscosity systems, use a high shear mixer or ball mill. With high shear mixing add SITUFF™ slowly until product is fully wetted. Ensure particles are wetted before continuing the addition. With low solids content ultrasonic mixing is also viable. - Under high viscosity systems, a ball mill or three-roll mill is recommended. Most pigment dispersion mills are also suitable. - Wetting agents and surfactants can be used and are recommended but not required. - Consider the use of P-SW or P-SWB pre-dispersed by Haydale Technologies Inc. 	<ul style="list-style-type: none"> - Pour and stir. Moderate shear mixing is adequate. - Wetting agents and surfactants can be used and are recommended but not required. - Consider the use of P-SF or P-SFB pre-dispersed by Haydale Technologies Inc. - Use the minimal amount of agitation to achieve dispersion. Excessive agitation will shorten the fiber length.
Solvent (Includes organic solvents, monomers, oligomers)	<ul style="list-style-type: none"> - Add SI-TUFF™ slowly to solvent under high shear mixing. Ensure particles are wetted before continuing the addition. - A ball mill, three roll mill, or any pigment mill is also suitable. 	<ul style="list-style-type: none"> - Pour and stir. Moderate shear mixing is adequate. - Use the minimal amount of agitation to achieve dispersion. Excessive agitation will shorten the fiber length.

Assessing Dispersion Quality

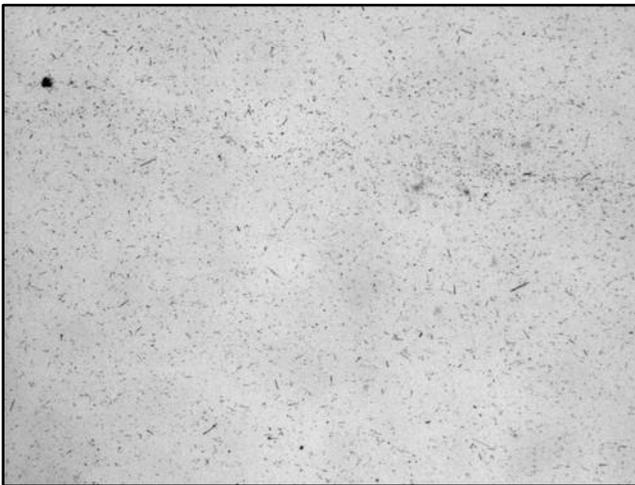
Assessing the quality of dispersion is straightforward. A “slide check” using low magnification optical microscopy is recommended. After the dispersion is made, draw a sample using a small pipet. Place a few drops of dispersion on a glass slide. The dispersion can be diluted with water or solvent on the slide, if desired. Using a backlit microscope, survey the entire slide for any lumps. Lumps are “balls” of SI-TUFF™ where the outer layer of the ball is wetted by the dispersant, but inside the ball it is still dry. If you see any lumps, the dispersion is not yet suitable for use. Further mixing or milling is required. The photographs below show dispersions that pass and fail the slide check test.



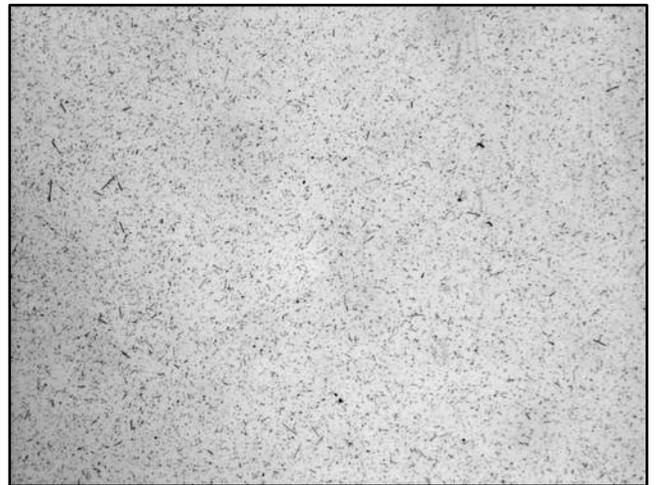
Fail: P-SW in water with no agitation (5X)



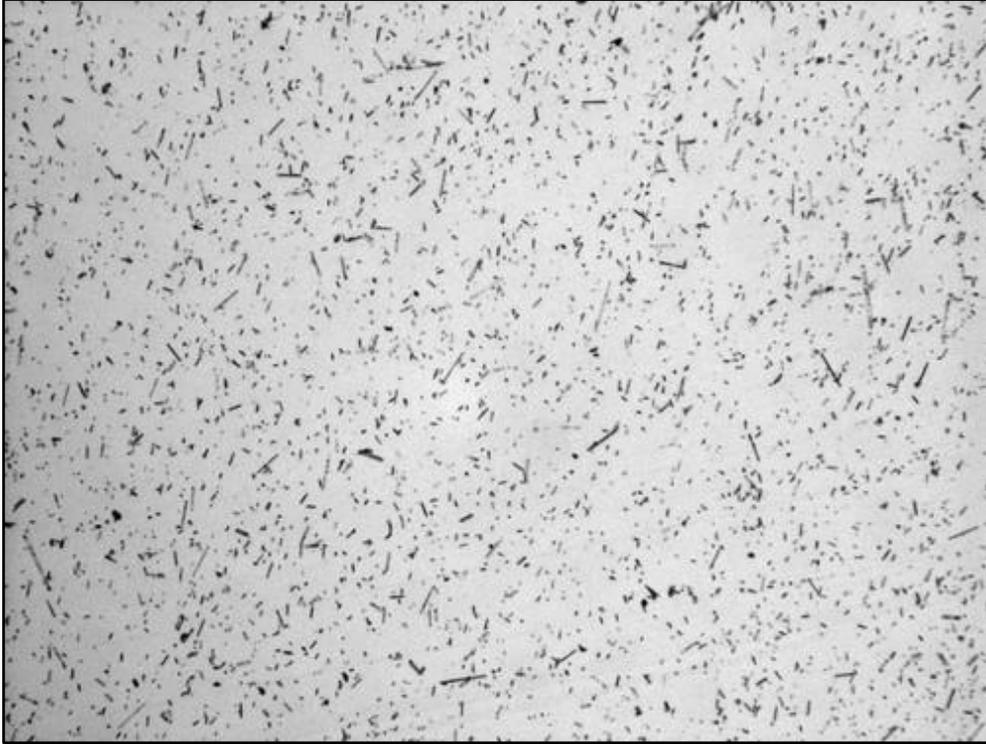
Fail: P-SW in water with insufficient milling (5X)



Fail: P-SW in solvent with insufficient agitation (5X)



Pass: P-SW in water (5X)



Pass: P-SW in water (20X)



Pass: P-SW in solvent (20X)