

User Protocol of GO Ink for Direct-Ink Writing

Chemicals Needed:

- (1) 3D Printable Graphene Oxide Ink (product [916579](#))
- (2) De-ionized water

Equipment/Consumables Needed:

- (1) Mixer container
- (2) Metal Spatula
- (3) Balance
- (4) Planetary Mixer
- (5) Syringe (with caps)
- (6) Syringe Nozzle
- (7) Syringe plunger
- (8) Direct-Ink Write (DIW) Printer
- (9) Liquid Nitrogen
- (10) Freeze drier

Step by Step Procedure for Ink Mixing and Loading into Syringe:

- (1) Place mixer container on balance and tare weight.
- (2) Using the metal spatula, scoop out desired amount of Ink ([916579](#)) from container into the mixer container on the balance.
(For reference, for filling a 10 mL syringe, 20 grams of the GO ink is sufficient.)
- (3) Once the desired amount of Ink ([916579](#)) is in the mixer container, using a planetary mixer, mix the ink using the following mixing sequence:
 - a. Mix setting @ 2000 rpm for 2 min.
 - b. Defoam setting @ 2200 rpm for 1 min.Repeat this mixing sequence twice. With hand mixing in between.
 - i) Note. Check the consistency and add required amount of de-ionized water <1 wt.% of ink and mix again until a smooth paste is obtained.
- (4) Once thoroughly mixed, the ink can be loaded into a capped syringe for DIW Printing. Using the metal spatula, scoop the ink from the container and deposit on the side of the syringe. Carefully tap the ink from the syringe wall to fill the syringe fully.
- (5) After all ink is loaded into the syringe. Place the syringe into the mixer and use the Defoam setting @ 2200 rpm for 10 seconds to eliminate trapped air bubbles that will cause inconsistencies in printing.
- (6) After plunger is placed into the syringe, ink is ready for printing.

Other Notes for DIW:

- Syringe Nozzle sizes ranging from 250 µm – 800 µm can be used.
- Initial pressure for DIW printing ranges from 12-18 psi, depending on nozzle diameter used.
- The ink can be directly printed on a glass substrate.

Post Processing of DIW printed parts:

- (1) The printed sample is subjected to freeze drying by placing it in liquid nitrogen. *Note. Directly immersing the sample in liq. Nitrogen might crack the sample due to thermal shock.*
- (2) The cryo-frozen samples are placed in a freeze drier to pull vacuum (0.104 mbar) and left under vacuum for 48h.
- (3) The freeze dried samples are then thermal annealed under inert atmosphere at 1050°C and held at 1050°C for 3h under a 2°C/min heating rate.