

Gas Diffusion Electrode (GDE standard)

What you need for the experiments:

- 1-2 GDEs from superaccu.com
- Al (preferably high purity), Mg, or Zn foil/sheet 4.4 cm x (7+3) cm
- Plastic box – Tic-Tac 49g
- 5-20% NaCl (with Mg anode) electrolyte
- or 5-20% KOH/NaOH* (using Zn or pure Al anodes) with optional ~0.02 M Na₂SnO₃ or 1 mM ZnO inhibitor addition
- Multimeter(s) (optional)
- Electrical model car (optional) or another electrical load (optimal 0.5 – 2 Ω)*

***NB! Hydroxide solution is corrosive. Wear safety glasses as hydroxide may be dangerous if it gets into eyes (if it happens, wash quickly with tap water for 15 min). Due to corrosion of Al in NaOH, do not unconnect load for more than a few seconds.**

Look at instructions (also supplementary): <https://doi.org/10.1021/acs.jchemed.2c00994>

GDE can be used with membrane in a sandwich mode (using magnets, tying with thread, etc) or attached to a vessel and filled with electrolyte. The size of the GDE is compatible with Tic-Tac 100 (49g) box or similar sized vessels.

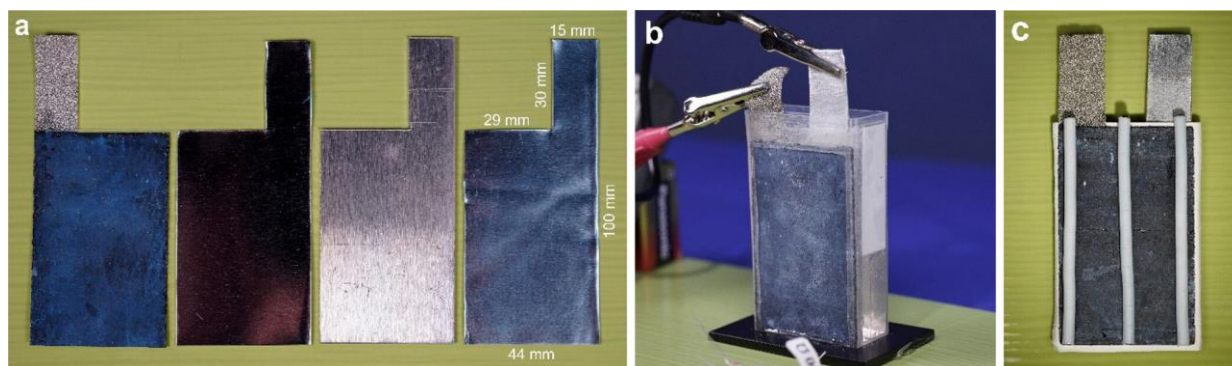


Fig. 1. GDE cathode, Al, Mg, Zn anode (a). Liquid-filled (b) and sandwich style cell (c).

How to attach the GDE on a plastic vessel for the liquid-filled style?

- 1) Cut a 42 mm x 68 mm hole on the wall of a Tic-Tac box.
- 2) Roughen a few millimeters area near the cut line inside of the plastic vessel with sandpaper.
- 3) Add 3 mm wide glue layer on the inside edge of the hole on plastic. Place GDE inside Tic-Tac box and press it against glue (gray side outside). Add glue to all edges so that 1 mm of the electrode gets covered. Add about 5 mm wide glue layer on protruding current collector so that it flows inside porous shiny metal mesh. Glue can be epoxy (3-5 min 2-component epoxy), but maybe also silicone or some other glue.
- 4) When glue is hardened, fill the modified vessel with pure water. In case of any leaks, find out leaking spots, dry it (by letting it stand in a dry place overnight), and add glue where needed.
- 5) The procedure can be repeated and second GDE can be added on the other side of the vessel. Now if there is only one GDE, the metal anode must be protected on the opposite side. A simple way is to cover it with transparent tape.

Note that Mg- or Al-air battery cell heats up itself, but maximal temperature should be lower than 50 °C – if necessary, cool it with ventilator (no overheating occurs with Zn or higher purity Al or Mg).

The GDE is reusable, just wash it thoroughly with distilled water then let it stand in water for 10 min and finally dry in air. Current GDE was characterized by OCP 1.4 V vs. Zn and can reach up to 0.7 A/cm² in 3-electrode measurements; however, the metal anodes will limit current and power density to much lower values than the GDE is capable of. High powers can be achieved only with special alloys and conditions (high temperature and electrolyte flow rate). Note that the GDE is not tested to be liquid proof for very long experiments (> 2 days) or at extended pressures and additional porous teflon layer might be needed for these cases. To stop the battery experiment, remove anode as well as electrolyte and wash the cell with water.

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