

Decapsulation of Integrated Circuits

Decapsulation, or de-cap, is a failure analysis technique which involves the removal of material packaging from an integrated circuit (IC). After de-cap, visual inspection by optical microscopy of the internal circuitry may reveal areas where damage is most likely to have occurred. In addition, scanning electron microscopy (SEM) with energy dispersive x-ray spectroscopy (EDS) can identify the composition of any anomalies present after de-cap under higher magnification. The removal process of package material can be done either mechanically or chemically depending on the design of the integrated circuit. With ceramic packaging, de-cap is usually done mechanically by chiseling off the top with a fine razor and small hammer. For plastic packaging, de-cap requires chemical etching by strong acids. In this Tech Tips article, de-cap by chemical etching will be outlined step by step.

Step 1:

Identify where the die is relative to the IC by x-ray inspection (Figure 1). The manufacturer datasheet may also provide information about the clearance from the top of the package to the die. Using a marker, draw an outline of the die on the top surface of the IC and mark the side for approximate depth to the die.

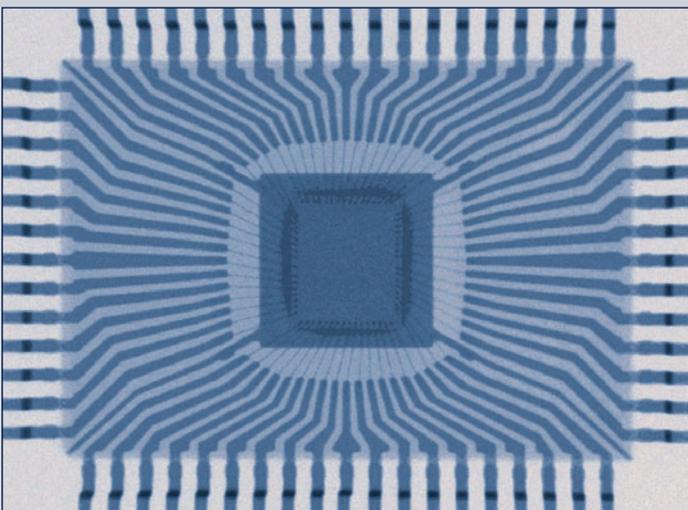


Figure 1: X-ray inspection of IC.

Step 2:

Attach an abrasive point to a Dremel® rotary tool (with variable speed control) and slowly drill a small cavity into the IC (Figure 2). Apply gentle pressure and keep within the outline and depth which you have marked on the IC. Use caution when drilling to avoid damage to the die and the wire bonds.

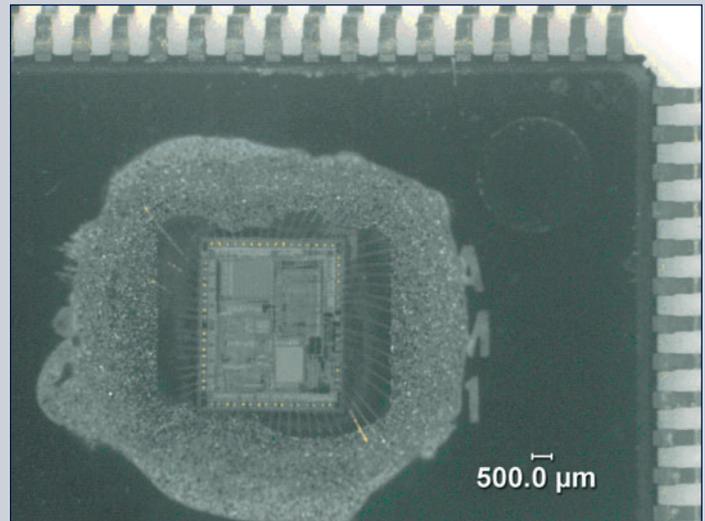


Figure 2: Cavity drilled in the IC (main image) and Dremel® abrasive point (inset image).

Step 3:

Prepare a hot plate in a fume hood and set the temperature to 100 °C. An acetone spray bottle, a waste beaker, and tweezers should be within reach. Also, several disposable pipettes should be available in the fume hood.

Step 4:

Following proper safety precautions (including a chemical lab coat/apron, safety goggles, and thick butyl gloves), pour out a small amount (10 to 15 mL) of fuming nitric acid and fuming sulfuric acid into separate labeled vials while under the fume hood.

Step 5:

When the hot plate has reached 100°C, dispense a few drops of fuming nitric acid into the drilled cavity. Allow the acid to etch the plastic packaging until the reaction appears to slow. Using tweezers, hold the IC over the waste beaker and flush with acetone to clean out the debris and flush any remaining acid. (NOTE: Acetone is extremely flammable! Keep away from the hot plate.) Once the die is exposed, switch to fuming sulfuric acid and remove the plastic packaging near the wire bonds following the same procedure. Stop etching when the acid can no longer remove plastic packaging or may damage internal circuitry (Figure 3).

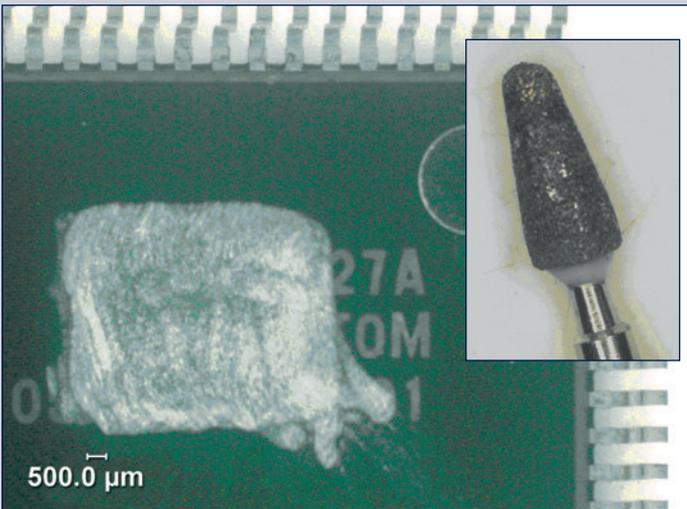


Figure 3: De-capped IC.

ACI Technologies has the capability and experience to perform de-capping of ICs for failure analysis. If you would like additional information, please contact the Helpline at 610.362.1320 or email helpline@aciusa.org.

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