

Pumice: A Full-Featured Abrasive for Printed Circuit Board Preparation

The pre-cleaning process of a printed circuit board (PCB)—and in particular its copper components—is key to establishing optimum conditions for the application of films and solder masks. The quality demands for PCBs continue to go up—tighter packing densities, finer structures, more robust adhesion—yet cost pressures remain relentless. Pumice scrubs are process-mature, cost effective and widely applicable.



PUMICE: THE ON-GOING INDUSTRY STANDARD

Pumice has been used extensively in the PCB cleaning/polishing/surface prep processes over the years, subsequently, machinery and methods have been developed and fine-tuned to use pumice as the abrasive agent.

Advances in machinery design, engineering and materials have broadened and tuned-up the effectiveness of the primary brush-and-slurry method, while

KEY CHARACTERISTICS OF HESS PUMICE:

- Specific gravity of 2.35 g/cc
- Low unit handling weight: 40 - 50 lbs cubic foot (depending on grade)
- MOHS-scale hardness: 6
- Due to its amorphous characteristics, pumice is not considered a health risk to the workers who handle it.
- Chemically, pumice is primarily Silicon Dioxide (Amorphous Aluminum Silicate), some Aluminum Oxide, and trace amounts of other oxides

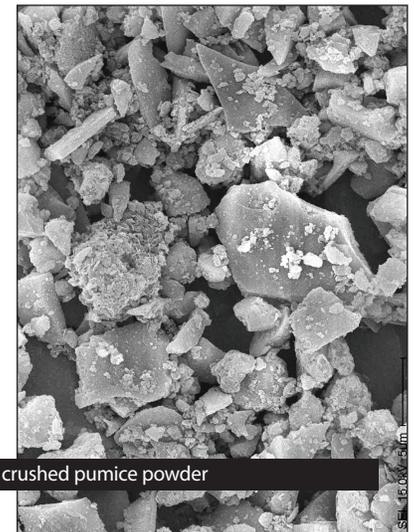
a brushless process known as jet scrubbing was also developed to provide an impingement-only cleaning process. These two processes have their pros, cons, and best-practice applications, but share a common abrasive component: pumice.

Other processes have been used, of course, but pumice-slurry processes still dominate. Why? Because pumice abrasives cost-effectively create a superior surface profile (critical to insuring good adhesion), mix effectively into a water-based slurry, and efficiently capture and remove contaminants.

WHY PUMICE

Pumice is a highly effective abrasive for several reasons, with the primary being its unique, nature-blessed structure.

Pumice is the result of violent volcanic action—water-infused magma thrown into the atmosphere, the water flashing to steam and frothy molten rock rapidly cooling as it falls to earth. The result is an amorphous foamed glass stone, made up of a maze of thin-walled, air-filled vesicles that, when crushed to grade, provide multiple abrasive edges. Also, the sponge-like structure of pumice—even crushed to a fine grade—makes it a very effective trap for catching and holding the contaminants and waste copper scrubbed free during the cleaning process.



crushed pumice powder

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Another of the valuable structural features inherent in pumice is its friable nature—meaning as it breaks down, it continues to expose sharp cutting edges rather than rounding off. This physical characteristic assures a consistent operating life-span.

WHY HESS PUMICE

Pumice, while abundant, is not created equal. Nor are the companies that mine and refine it. Fact is, Hess Pumice is in demand world-wide because, one, our pumice profiles as ideal for delicate and precise abrasive polishing processes like those for circuit boards, and two, it arrives on spec and on time.

- **Natural Purity.** Hess Pumice mines and refines the world's purest commercial deposit of white pumice. The purity of our pumice is a result of our pumice deposit being naturally scrubbed clean of heavy metals and contaminants and piled up by centuries of wave action from an ancient inland lake—a massive lake that once covered much of the state of Utah as well as parts of Idaho and Nevada.

- **Hardness.** Hess pumice is hard enough to abrade, yet soft enough not to damage or pit the surface (MOHS 6.0). Pumice abrasion cuts away oxidation and surface contaminants, leaving a superior toothy surface right in the sweet spot of the rms value, insuring optimum adhesion of dry-film and solder masks.

- **Relative Density.** Relative density (specific gravity) is usually expressed with respect to water, and the relative density of Hess Pumice (2.35 g/cc) allows it to remain easily suspended in a slurry, yet heavy enough to flush away in the rinse process.

- **Crystalline-Silica free.** The non-crystalline nature the silica component of Hess Pumice means our pumice is safe to handle.

- **Processing and Logistical Expertise.** Hess began supplying pumice to the abrasives industry in the late sixties—an industry that demanded our dense, pure, carefully graded product for polishing television glass—and quickly grew to meet the world-wide demand. When printed circuit boards came along, our pumice was a natural fit.

Although early pumice-scrubbing machine designs lacked the foresight to avoid maintenance and self-destructive problems—machine gaskets, bearings and other mechanisms were exposed to the pumice abrasive slurry—the pumice-polished results were unmatched, and scrubbing machinery soon evolved to the well designed, carefully built, customizable/modular offerings available today¹.

PUMICE-BASED ABRASIVES VS. OTHER PROCESSES AND ABRASIVE TYPES

Other Processes. Research into processes that surfaces for adhesion for dry film photoresist found that pumice scrubbing provided the best surface profile². Other scrubbing processes (like a polymeric matrix mat or nylon bristles impregnated with silicon carbide particles) not only failed to provide a comparable film-ready surface, but even to attain an adequate surface required a careful control and balance of the scrubbing process.

Chemical cleaning processes have their place in certain situations, such as cleaning thin-core laminates where dimensional distortion may be a concern. You can even source specialized chemical-enhanced pumice-based scrubs, such as an acidified pumice scrub—the acidic enhancement designed to promote cleaning (chemically strip light oxides and provide anti-oxidant protection) as well as deliver the necessary surface-etch topography.

Other Abrasives. Aluminum Oxide—harder (MOHS 9) than pumice, abrades more aggressively, more expensive—is sometimes used in place of pumice for specialized scrubbing applications and processes. But the choice to substitute aluminum oxide for pumice tends to be for perceived process-improvement reasons—not final surface quality. If final surface quality—especially on delicate substrates—is of supreme importance, pumice is used. For example³, aluminum oxide does not break down to fines as rapidly as pumice, and hence is perceived to last longer. But those longer-lasting (and hence, longer-used) aluminum oxide particles round off, losing their abrading edges. These smooth, hard particles then peen the copper, rather than abrade it, creating a poor surface for film adhesion.

[1] Of interest is this statement found in an equipment brochure from International Supplies S.r.l.: "If the first pumice scrubbers had been adequately constructed, then other surface treatments would probably never have found a place in this industry."

[2] *Adhesion in Photopolymeric Systems*, L. Fullwood; *Adhesion Aspects of Polymeric Coatings*; pgs. 512-513

[3] *Effects of Copper Foil type and Surface Preparation on Fine Line Image Transfer in Primary Imaging of Printed Wiring Board*. Adams-Melvin, McGregor, and Dietz; pg. 4