Lichtenberg Pictures??

Memories are always in the making; birthdays, graduations, weddings, sweet 16ths.

Naturally, there exists a desire to preserve them. There have been many mediums through which this has been accomplished: stone/metal/glass/wood carvings, sculptures, charcoal, pastel, watercolor, bits in silicon, video, digital LCD frames, music, writing, etc. Let's add one more to the list: acrylic Lichtenberg Figures?

Lichtenberg figures are essentially "trapped lightning strikes" generated from the breakdown of dielectrics at high voltages. They appear on insulators and are especially common on high voltage equipment where insulation failure has occurred. Lightning strike victims may also bear Lichtenberg figures on their skin. Artificial figures are generated by implanting insulators with many electrons via a linear accelerator to a fixed depth determined by the exiting velocity of the electrons. Because insulators perform well to keep charges from moving, the electrons remain trapped in the insulator. A sharp tipped metal spike is then tapped at the corner of the insulator, causing a massive rush of most of the trapped electrons out to the conductor. The discharge takes place in the time span of a few hundred billionths of a second.

Many of these created masterpieces are produced in acrylic, aka Plexiglas, which is clearer than glass and generates amazing opaque white fractal trees where the breakdowns have occurred. This allows for easier observation of the trees as the undamaged Plexiglas remains clear.

The pattern generated in the short time span of the discharge is always a fractal tree, even in 3D Lichtenberg figures. The idea of having an image embedded in acrylic is too good to resist. So how can it be achieved given that the electron embedding/discharge technique works to produce fractal images? One thing is for sure: controlling the path of electrons through the dielectric during the hundred billionths of a second discharge would be…challenging. Another consideration would be to perform multiple discharges with varying discharge points (as dictated

by the pixels of the image). This approach has many loose ends. What effect would be generated if an already broken-down dielectric is implanted with electrons and then re-broken-down? Will the new fractals branch off of the existing fractals? That would be disastrous to realize a semester into the project. Another downside is the need for a linear accelerator, which would be bulky and expensive.

So is this a dead end? Maybe not. We know that the embed/discharge approach works on the idea of dielectric breakdown. With a little more research into dielectric breakdown, one can see that the dielectric strength of Plexiglass can range from 450-990 V/mil ~ 18KV-35KV/millimeter. In order to cause a 0.093" (2.3622 millimeter) piece of Plexiglass to breakdown, a voltage potential between 2.3622 millimeters*(18KV-35KV/millimeter) = 43 to 83 KV is required. This is promising because such voltages are achievable with a Cockcroft-Walton voltage multiplier bundled with a high voltage ac supply (neon sign). One question remains. How much charge must flow through the dielectric? If multiple dielectric breakdowns are induced vertically on the thin sheet of Plexiglass, will the sheet still be somewhat intact in structure to support a picture frame? How much charge is required to achieve a decent observable white opaque effect as with Lichtenberg Figures? Can the opaqueness of the effect be controlled by the amount of charge flowing through the breakdown? What effect would increasing the voltage much past the dielectric strength have?

If and when answers are obtained to these questions with any good news, the project would be a go. A CNC machine mounted with a specially designed HV discharge head controlled by computer can easily make Lichtenberg inspired advanced plasma etching possible. Unfortunately there are too many obstacles to overcome. There are many dangers as well related to storing energy are high voltages. There is also toxic ozone generated from any leaking corona. There are, sadly, too threats to the project to pursue it as a senior design project.