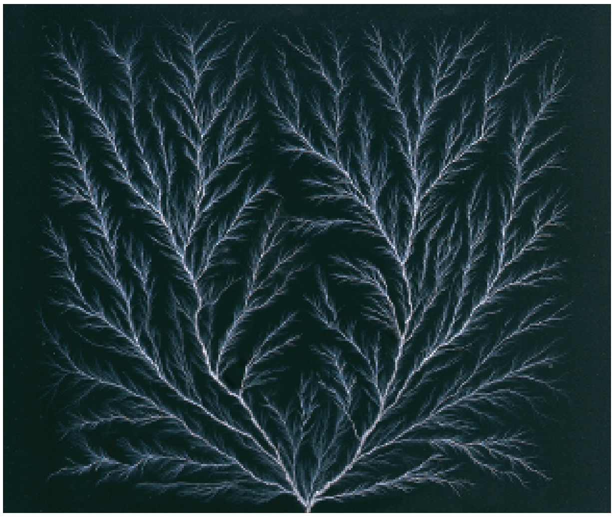

Figure 8
The markings caused by electrical breakdown in this material look similar to the lightning bolts produced when air undergoes electrical breakdown to form a plasma of charged particles.

By substituting the definition of capacitance ($C = Q/\Delta V$), we can see that these alternative forms are also valid:

$$PE_{electric} = \frac{1}{2}C(\Delta V)^2$$

$$PE_{electric} = \frac{Q^2}{2C}$$

These results apply to any capacitor. In practice, there is a limit to the maximum energy (or charge) that can be stored because electrical breakdown ultimately occurs between the plates of the capacitor for a sufficiently large potential difference. So, capacitors are usually labeled with a maximum operating potential difference. Electrical breakdown in a capacitor is like a lightning discharge in the atmosphere. **Figure 8** shows a pattern created in a block of plastic resin that has undergone electrical breakdown. This book's problems assume that all potential differences are below the maximum.

SAMPLE PROBLEM B

Capacitance

PROBLEM

A capacitor, connected to a 12 V battery, holds 36 µC of charge on each plate. What is the capacitance of the capacitor? How much electrical potential energy is stored in the capacitor?

SOLUTION

Given: $Q = 36\ \mu C = 3.6 \times 10^{-5}\ C \qquad \Delta V = 12\ V$

Unknown: $C = ? \qquad PE_{electric} = ?$

To determine the capacitance, use the definition of capacitance.

$$C = \frac{Q}{\Delta V} = \frac{3.6 \times 10^{-5}\ C}{12\ V}$$

$$\boxed{C = 3.0 \times 10^{-6}\ F = 3.0\ \mu F}$$

To determine the potential energy, use the alternative form of the equation for the potential energy of a charged capacitor shown on this page:

$$PE_{electric} = \frac{1}{2}C(\Delta V)^2$$

$$PE_{electric} = (0.5)(3.0 \times 10^{-6}\ F)(12\ V)^2$$

$$\boxed{PE_{electric} = 2.2 \times 10^{-4}\ J}$$