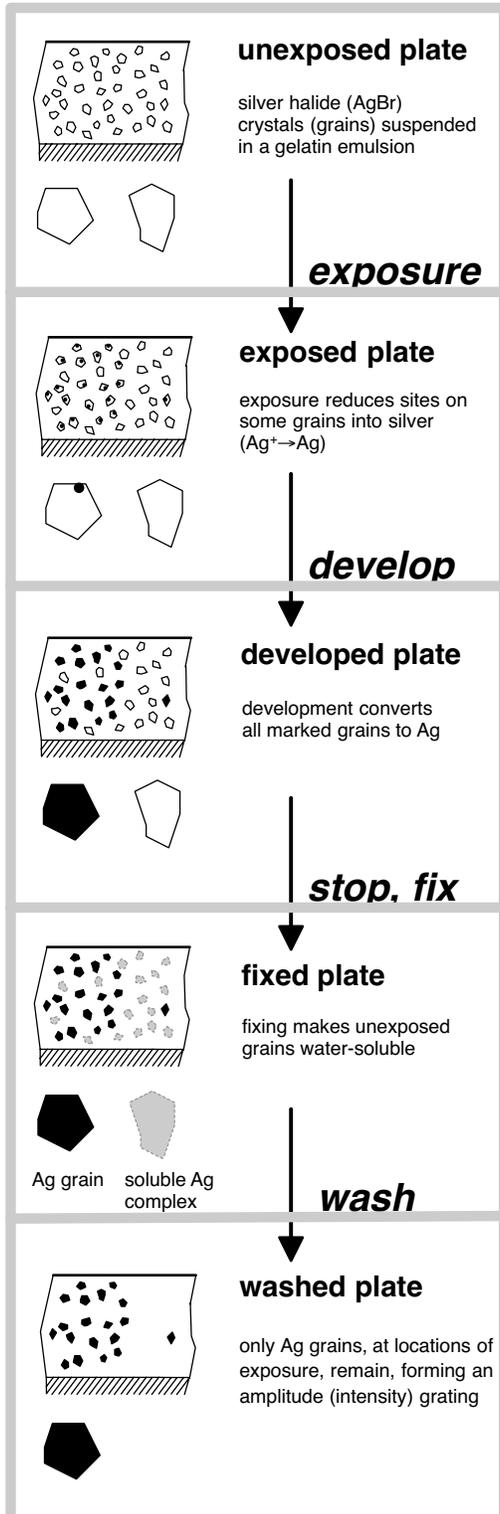


Basic Holographic Photochemistry

MAS.450/854 (Last modified Feb 18, 2003)



The basics of holographic photochemistry are very similar to those of black and white photography. Photosensitive plates are made of silver halide microcrystals or "grains" (mostly silver bromide with some silver chloride) suspended in a gelatin binder (the grains and gelatin together are called an "emulsion"), which is in turn coated onto a glass or plastic substrate.

During exposure, some of the photons of light are absorbed by the silver halide crystals and produce "electron-hole pairs," in which the electron is quite mobile, and the positively charged silver ion is relatively stationary. Some of these mobile electrons eventually find their way to the crystal surface and combine with silver ions to form tiny stable clusters of silver metal atoms, which are specks in the emulsion that collectively constitute the "latent image." As the exposure continues, photons strike some part of more and more crystals, marking each of them.

Wet development amplifies the latent image by converting the silver halide grains that have been marked with a silver speck entirely into metallic silver. Silver grains of this small size appear black and opaque. **Developers**, the chemicals responsible for development, are weak reducing agents - that is, they provide extra electrons during the development process. Besides their reducing properties, developing solutions may also contain agents that control alkalinity, dissolve the silver grains slightly or interact with the emulsion gelatin.

After the prescribed development time, the plate is placed in a dilute solution of a weak acid (usually acetic acid), known as **stop bath**. Most developers are active only when alkaline, so the stop bath immediately halts the conversion of silver halide to metallic silver grains. It then rinses most of the developer out of the gelatin.

After the stop bath, the plate moves to a solution of a silver halide solvent, usually sodium hypthiosulfate or "hypo." This solution, called the **fixer**, dissolves the unexposed and undeveloped grains, leaving behind only the black silver grains. At this point, the plate is no longer sensitive to light. That is, the image is now fixed in place and won't change.

Following fixing, the plate is washed in filtered water. The **water bath** washes out any soluble silver complexes and residual chemicals. Only metallic silver grains remain in the emulsion. In black and white photography, this silver would

form the dark part of a photographic image. In holography, the silver grains make up the fine-scale grating structure that will diffract light.

The final step is **drying**. When wet, the emulsion swells to five to seven times its original thickness. As the water is removed, the gelatin shrinks dramatically and "catastrophically." That is, the layer attempts to be either fully swollen or fully shrunken, and water moves laterally through the gelatin to allow this to happen. The result is that a drying "edge" or "front" sweeps across the plate as it dries. Any dirt or flaw causes the front to "hang up" and produce an isolated island of wet gelatin, which slowly dries and leaves what is called a "water spot." In holograms, these water spots become especially visible because of the distortion of the gelatin layer than accompanies them. To minimize these effects, a small amount of surfactant (a surface tension reducing agent such as Kodak's PhotoFlo) is added to a final rinse so that the water sheets off of the plate more smoothly. Much care must be taken to avoid other drying defects during this critical step.