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A MODIFIED HYPERSENSITIZATION PROCEDURE FOR EASTMAN KODAK I-Z SPECTROSCOPIC PLATES

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A hypersensitization procedure for Eastman Kodak I-Z spectroscopic plates is described. The primary objective was to minimize or eliminate nonuniform plate fog. This procedure gave a mean plate fog density and density range of 0.28±0.01. The hypersensitizing agent is, typically, an ammonium hydroxide solution, and use is made of an acetic acid mixture as a stop bath. Some effects of bath temperature, ammonium hydroxide concentration, and hypersensitized plate storage are given. An approximate value of 350 to 450 was obtained for the increase in sensitivity of a hypersensitized I-Z over an unhypersensitized I-Z.

INTRODUCTION

In the course of general planetary photography at this observatory, the writers felt that occasional photographs in the farthest accessible infrared region of the spectrum would be useful. This necessitates the use of hypersensitized Eastman Kodak I-Z plates and a Schott UG-8 filter (or equivalent), a combination that isolates the region from 1.0 to 1.1 microns within a 10% cutoff value. In the past poor results have often been experienced, both here and at other observatories, in hypersensitizing I-Z plates; in particular, nonuniform plate fog density has severely limited the usefulness of the plates. To overcome this, some techniques are employed which virtually eliminate this nonuniform fog level. The hypersensitization procedure described in this paper is a modification of the procedure recommended by the Eastman Kodak Company[1]. It utilizes a stop bath of acetic acid in alcohol[2] following the ammonia bath.

PROCEDURE

The procedure involved three baths used in consecutive order. In the first, the plates were hypersensitized by bathing them for three minutes in a 2% solution of 29.4% ammonium hydroxide in distilled water (hereafter, references to the 29.4% ammonium hydroxide stock solution will simply be denoted by ammonia). The plates were then transferred to the second bath, a 2% mixture of acetic acid in 90% methyl alcohol where they remained for one minute. The acetic acid quickly neutralizes the residual ammonia and prevents further differential hypersensitization on the plate while it is being washed. Thus it is this bath that is all-important for maintaining a uniform density. The methyl alcohol tends to dilute, at least partially, water carried over from the first bath. The plates were then transferred to the third bath of 90% methyl alcohol and bathed for three minutes. This removes most of the water remaining on the plates and facilitates rapid drying. In all three baths, constant agitation was used. The plates were dried using the blower of a refrigerated room air conditioner for five minutes at a

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[1] E. W. H. Selwyn, *Photography in Astronomy* (Eastman Kodak Company, Rochester, New York, 1950), 1st ed., Chap. 3, pp. 62-63.

[2] [illegible], Personal communication to B. A. Smith (1964).

temperature of about 8°C. All three baths were kept at a temperature of 5±1°C by using ordinary pyrex ovenware immersed in an ice and water bath.

The procedure was fairly rapid, as two plates were hypersensitized simultaneously in approximately fifteen minutes. The distilled water, ammonia, methyl alcohol, and bathing containers were pre-cooled in a refrigerator. Thus we were able to begin the process immediately after mixing the solutions, as no time was required to cool them to a suitable temperature.

RESULTS

We attempted primarily to devise a system which would give the least variation in plate density and, at the same time, gain as much sensitivity as possible. Several experiments were carried out to determine what we felt would be the best temperature and ammonium hydroxide concentration for hypersensitization, and to determine the effects of storage on hypersensitized plates.

The hypersensitization procedure was used at two different bath temperatures—5±1°C and -1±1°C. The latter temperature was obtained by the addition of salt to the ice and water bath. Ammonia solutions of 2, 4, and 8% were used at 5°C, and ammonia solutions of 4,8, and 16% were used at -1°C. After hypersensitizing, each plate was exposed for one second to record a set of sensitometric spots for the determination of relative sensitivity and then developed immediately. The sensitometric printer employed an unregulated tungsten light source behind a diffuser screen, a Schott UG-8 filter, and neutral density filters in five density steps in front of the five spot apertures.

The results are shown in Table I. The plates hypersensitized at 5°C showed no appreciable effect as the ammonia concentration was increased. Their mean plate fog density, density range, and relative sensitivity remained essentially constant. On the other hand, the plates hypersensitized at -1°C, while having a lower mean plate fog density, had a density range that increased with an increase in the ammonia concentration. It was also found that these plates were considerably less sensitive than those hypersensitized at 5°C, as indicated in Table I. The relative sensitivity is here defined as the inverse of the exposure (with arbitrary intensity units) at a density of 0.60 above fog.

When the 8 and 16% ammonia solutions were used at -1°C, many small areas, randomly scattered on the plates, were apparently not hypersensitized. These areas ranged in size from several millimeters to less than a millimeter in extent. They may possibly have been caused by the observed formation of ice crystals in the ammonia bath or possibly, as was suggested to us, by a fractionation process in the gelatin of the emulsion.

Because of the greater sensitivity with uniform plate fog density, and because of the uncertainty of obtaining good quality plates at -1°C, it was decided to maintain the bath temperatures near 5°C.

It was seen in Table I that there was no appreciable difference in plate fog density with an increase in the ammonia concentration at temperatures near 5°C, provided they were developed quickly after hypersensitization. However, there was an apparent correlation between the ammonia concentration and the plate fog density when plates were stored unrefrigerated for several days. As indicated in Table II, greater ammonia concentrations resulted in an increase in the mean plate fog density. In all four cases, the density range was large. As a result of this, we chose the 2% ammonia solution.

The ability to keep hypersensitized (2% ammonia solution) I-Z plates in storage was found to be extremely critical with regard to the temperature and to the time of storage. Under no circumstances should plates be stored for an extended period at room temperature (20°C). At a storage temperature of 0°C, the plates should be used within a few hours. Under deep-freeze conditions of -25°C, the plates may keep as long as forty-eight hours, although nonuniformity in density was becoming apparent in our test plates. A desiccant was not used with the plates in storage; however, it may be desirable to do so. It must be pointed out that if one desires a very even background, it would be wisest to use the plate as soon as practical after hypersensitization.

The difference in sensitivity, at the 1.0 to 1.1 microns range, of an unhypersensitized I-Z and a hypersensitized I-Z was roughly determined using an intense flood lamp (unregulated) with a commercial camera. The best exposures were estimated as being between 4 and 5 seconds at f5.6 for the unhypersensitized I-Z and 0.35 seconds at f32 for the hypersensitized I-Z. These values give an approximate increase in sensitivity of between 350 and 450, disregarding possible failure of the reciprocity law. Exposure times are considerably longer for planetary photography and further studies are planned utilizing more practical exposure ranges with refined techniques.

With the technique described it appears to us that the hypersensitization of I-Z plates is much more promising than in the past. It is a relatively fast procedure and does not unduly lower the plate quality.

We feel that the hypersensitized I-Z plate now has capabilities for many direct-photographic and spectroscopic purposes for which it may not have been suitable for in the past.

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TABLE I

EFFECT OF BATH TEMPERATURE AND AMMONIA CONCENTRATION IN HYPERSENSITIZING I-Z PLATES[a]

Per Cent Ammonia[b]	Mean Plate Fog Density 5°C	Density Range 5°C	Relative Sensitivity 5°C	Mean Plate Fog Density -1°C	Density Range -1°C	Relative Sensitivity -1°C
2	0.27	+0.01 -0.01	0.021	--	--	--
4	0.28	+0.00 -0.01	0.018	0.16	+0.00 -0.01	0.005
8	0.28	+0.00 -0.01	0.018	0.18	+0.01 -0.02	0.010
16	--	--	--	0.17	+0.08 -0.02	0.009

[a] Unhypersensitized I-Z: mean plate fog density = 0.14; density range = 0.00.

[b] Indicates the quantity of a 29.4% ammonium hydroxide stock solution diluted in distilled water. Thus, "2%" actually represents an ammonium hydroxide concentration of 0.006.

TABLE II

EFFECT OF AMMONIA CONCENTRATION ON I-Z PLATE FOG WHEN STORED AT 20°C FOR SIX DAYS FOLLOWING HYPERSENSITIZATION

Per Cent Ammonia	Mean Plate Fog Density	Density Range
2[a]	0.49	+0.02 -0.03
4	0.70	+0.18 -0.08
8	0.83	+0.07 -0.04
16	0.98	+0.15 -0.08

[a] Stored at 20°C for two days.