of the laser beam structure and independent of the sample properties.

In summary, while this investigation has shown that the ground glass and waveguide homogenizers reduce, but do not entirely eliminate hot spots from multimode laser beams, the use of a cavity aperture of proper size is effective in completely suppressing these micro-inhomogeneities. This detailed investigation into the microstructure of laser beams may have particular importance to the field of very large scale integration technology, where the use of lasers in device fabrication and annealing requires optical beams of spatial uniformity over dimensions of microns.

The authors wish to acknowledge J. E. Davey and A. Christou for their support in this investigation.

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Controlled shifting of the spectral response of reflection holograms

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Dichromated gelatin (DCG) is regarded as one of the best holographic recording materials due to its grainless structure yielding high resolution, and its capability of reconstructing wave fronts with high diffraction efficiency (DE). This material, unfortunately, is insensitive to light of wavelength much longer than 540 nm.[1] Much work has been done to extend the spectral sensitivity of DCG to the red wavelengths of the He-Ne and Kr lasers. Adding suitable dyes such as methylene green[2] or methylene blue[3,4] to the dichromate sensitizing solution yields dye-sensitized dichromated gelatin (DSDCG). High DE was reported for plates coated with these materials.

It was found, however, that these high DE values could not be achieved in one of the construction geometries we use, namely, the back-mirror geometry, Fig. 1. The spherical wave front here represents the reference beam which passes through the photosensitized layer striking the mirror. The wave front reflected by this mirror forms the object beam.

Recording in this geometry requires a double pass through the sensitized layer. Absorption at the construction (exposing) wavelength must be kept low to achieve a beam ratio compatible with needed fringe visibility and desired high DE. Simultaneously, though, high absorption of the DSDCG layer at the construction wavelength is needed for good photographic sensitivity. This competition between beam ratio and photographic sensitivity precludes the use of DSDCG for back-mirror-formed holograms. A conventional two-beam geometry would allow the use of DSDCG because the ratio of the independent beams could be adjusted regardless of DSDCG layer absorption; but such an arrangement is difficult to achieve with very large systems.

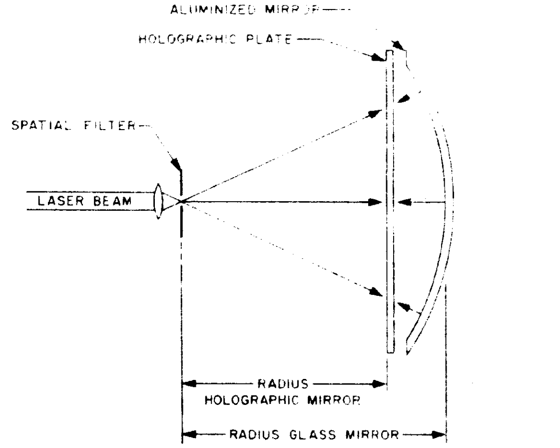

Fig. 1. Back-mirror geometry used for reflection hologram construction.

In this Letter we present a method of producing high DE, red wavelength responding reflection holograms with the green 514.5-nm line of the Ar laser. Experimental results for DE, wavelength response and bandwidth are given for holograms obtained by this method.

Gelatin films 54 × 61 cm were produced by a gravity coating method and were sensitized with an ammonium dichromate solution. Formulation of the gelatin and concentration of the ammonium dichromate solution were varied as coatings of differing hardness were produced. These photosensitized coatings were then exposed to the interference pattern of oppositely directed divergent and convergent wave fronts as in Fig. 1. The exposure was made with a cw Ar-ion laser operating at 514.5 nm.

The total irradiance at the exposure plane was 1.64 mW/cm^2, and the light sensitive coating was exposed to 41 mJ/cm^2 of irradiation. The irradiance due to the reference beam was 1.0 mW/cm^2 and was 0.64 mW/cm^2 due to the object beam; the irradiance was equal to the reference beam's irradiance less attenuation by the 20% absorption of the emulsion to light of 514.5 nm and 80% reflection of the aluminum coated mirror. This yielded an acceptable beam ratio of 1.6. This construction geometry will produce a holographic spherical mirror. The peak reconstruction wavelength λ_r diffracted by the hologram would then depend on the spacing of the recorded fringe planes $\lambda_r = 2nd \sin\theta$, with d the distance between fringe planes, n the index of refraction of the gelatin, and θ the Bragg angle.

Due to swelling of the emulsion during development, the distance between fringe planes d is usually larger than that recorded during the exposure. Therefore, a hologram produced with light of 514.5-nm wavelength may reconstruct with its λ_r at a longer wavelength.

In this way a hologram can be produced with the 514.5-nm line of the Ar laser which will have a λ_r up to 595 nm. It was found, however, that to produce a hologram with $\lambda_r > 595$ nm required a new process.

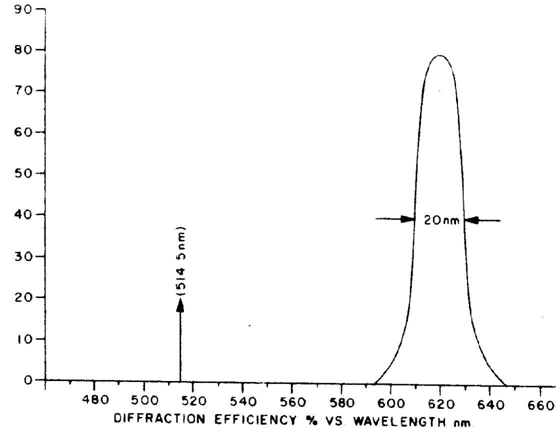

Fig. 2. Spectral response of a hologram shifted to the red.

To produce holograms with a longer λ_r, the gelatins were sensitized and exposed as before but were developed with an additional step, a hardening step using an inorganic hardener. The effect of the additional step of treating the swollen gelatin is to increase its resistance to returning to its normal thickness and normal fringe spacing d during the dehydration step. The chemical process of gelatin hardening has been described as a cross-linking of carboxyl groups in the gelatin.[5] It is theorized here that more than just simple cross-linking of the carboxyl groups is taking place. Besides forming cross-links, the salts of the inorganic hardener will precipitate due to a weakly acidic gelatin medium and their insolubility in the propanol bath of the development process. The precipitate left in the gelatin volume increases the resistance of the gelatin returning to its construction thickness. This packing of the gelatin with precipitate, not the cross-linking, seems to be the major factor at work here.

By adjusting the hardener concentration (for gelatins of differing original hardnesses), the process may be controlled so as to produce a stable swollen state for the gelatin while keeping the scatter due to precipitate low. In this way holograms were produced which were constructed with a construction wavelength λ_c of 514.5 nm and reconstructed with a λ_r as high as 680 nm. The bandwidths of these holograms are ~20 nm, similar to those holograms processed without the extra hardening step. The uniformity of λ_r across the holograms' large aperture is similar to that of holograms not shifted which are very uniform varying only ±2 nm. The scattering is <4% and the DE nearly 100%. Figure 2 shows the spectral response curve of a typical red hologram.

In summary, what was achieved was a shifting of the wavelength response of volume phase reflection holograms from the construction wavelength to a much longer reconstruction wavelength. It is, therefore, possible to produce a reflection hologram with a reconstruction wavelength as long as 680 nm using a construction wavelength of 514.5 nm.

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Generalized Lorentzian approximations for the Voigt line shape: errata

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Four errors appeared in this paper.[1] Readers should note the following corrections:

1. Page 259, left-hand column, 18th line, Eq. (3): $b = \Delta\nu_D (2\ln 2)^{-1/2}$ should read $b = \Delta\nu_D\, [2(\ln 2)^{1/2}]^{-1}$;
2. Page 260, left-hand column, 42nd line, Eq. (6): $z = d + ip = \frac{D}{b} + i\frac{\alpha}{b}$ should read $z = p + id = \frac{\alpha}{b} + i\frac{D}{b}$;
3. Page 260, right-hand column, 18th line, Eq. (12): $V_1(z) = \frac{1}{1+\sqrt{\pi}}$ should read $V_1(z) = \frac{1}{1+\sqrt{\pi}z}$;
4. Page 260, right-hand column, 31st line, denominator of Eq. (14): $(\pi - 2)\sqrt{\pi} + \pi z + (1-\pi)\sqrt{\pi}z^2$ should read $(\pi - 2)\sqrt{\pi} + \pi z + (4-\pi)\sqrt{\pi}z^2$.

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Spectroscopic observations of O VII and O VIII near 2 nm with aluminum and polypropylene filters

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Grazing incidence monochromators are often used in research on tokamak devices to study the radiation between 10 and 40 nm emitted from plasmas by metallic and low-Z impurities.[1,2] These instruments are capable of operating at wavelengths down to nearly 1 nm; however, in typical applications, no useful data can be obtained below 10 nm because of intense background light.[3] This Letter describes the use of polypropylene and aluminum filters in series to eliminate scattered, long wavelength light from a grazing incidence monochromator installed on the Doublet III tokamak. With this pair of filters, the 1s–2p resonance lines of O VII and O VIII are routinely observed with a good signal-to-background (S/B) ratio.

A Minuteman model 310 grazing incidence spectrometer, with a 1-m Rowland circle, an 87° angle of incidence, and gold-coated conventionally ruled gratings with 600 and 1200 grooves/mm, was used for the work described here. The instrument can be operated in the photographic or the monochromatic mode. For photographic work, Kodak SWR film was used; for photoelectric measurements in the monochromatic mode, a Galileo continuous dynode electron multiplier (CDEM) was employed.

In photographic spectra taken without the aid of a filter, the 1.90-nm line of O VIII, the 2.16- and 2.18-nm lines of O VII,