B—6—12

High Density Video Signal Recording in a New Amorphous Chalcogenide Thin Film

M.Terao, K.Shigematsu, M.Ojima, Y.Taniguchi, S.Horigome, and S. Yonezawa
Central Research Laboratory, Hitachi Ltd.
280, Higashi Koigakubo 1-chome, Kokubunji Tokyo 185, Japan

As-Te-Se amorphous chalcogenide thin films are superior to known thin films[1, 2] as laser-hole-creation type recording films for direct-read-after-write optical video-disk applications. This new film has been developed after systematic study of available films. Creation of smaller holes than focused laser spot becomes possible by coating the substrate surface with cellulose acetate.

Development of the thin film was carried out considering hole shape as well as sensitivity to laser beams, reflectivity, and long-term stability. This is because irregularities in hole shape remarkably increase the noise in read-out video signals. Clean holes were obtained in As-Te system thin films. The arsenic-concentration in As-Te thin films should be larger than 10 atomic percent to create clean holes as shown in Fig. 1. Transmission electron diffraction patterns of As-Te thin films revealed that the films are amorphous. The amorphous state is desirable because random reflection of the "read" laser beam by crystal grains can be avoided.

Tellurium, Se, and S are high viscosity materials, because they have various lengths of atomic chains. For example, typical viscosity of Se at just above its melting point is 22.64P [3]. Clean holes could be created in Se thin films. In Te thin films, the hole shape was not clean enough due to the formation of small Te balls in and around the hole. However, addition of As or a small amount of Ge to Te resulted in clean hole formation. This is considered to occur because the addition of these elements raises the viscosity by cross-linking Te chains[4]. These results seem to show the importance of appropriate film viscosities.

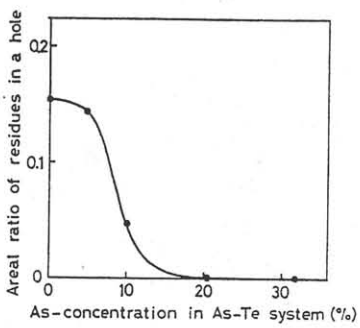

Fig. 1 Amount of residues in a hole

The required incident laser-beam power for recording in an As-Te thin film on a polymethylmethacrylate (PMMA) substrate rotating at 1800min^{-1} is about 10 mW at a wavelength of 488nm. The sensitivity of the thin film is nearly panchromatic. This permits the use of small sized lasers, e.g. semi-conductor

lasers. The addition of Se to the As-Te thin film, with increasing Se and Te concentrations near the film surface, greatly increases film stability by inhibiting formation of As and Te oxides. No changes have been observed in record and read characteristics after 6 months in air. Very small holes, about 0.6μm in diameter, which is smaller than the focused laser spot, could be created by coating the PMMA substrate with cellulose acetate (CA). This permits very high density recording, and shows the importance of appropriate substrate adhesion power. The CA coating is also effective for decreasing noise due to substrate surface roughness and decreasing recording laser power.

A prototype high-speed random-access picture file with a capacity of 20,000 still color pictures per disc has been developed using the new As-Te-Se thin film as the recording film. Frequency modulated NTSC video signals have been recorded on the disc. The recorded signals can be read out using reflected light with a large signal level owing to the high reflectivity of the recording film. This permits the use of a simple recording and reading head. An SN ratio of about 45db was obtained. Long storage life is certified because the information is recorded in the form of holes, and the disk has a dust proof structure as shown in Fig.2. Examples of created holes and reproduced color pictures are shown in Figs. 3 and 4, respectively.

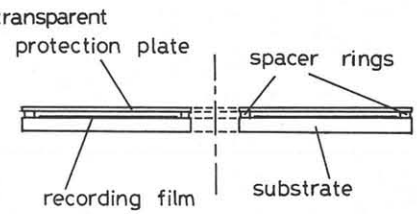

Fig.2 Cross sectional view of the disk

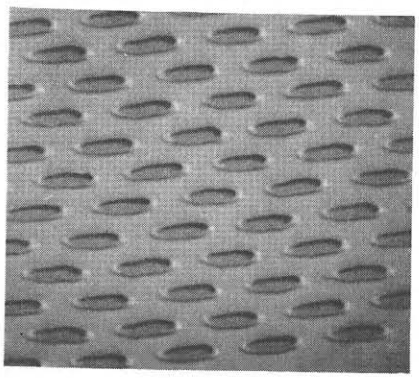

Fig.3 SEM photograph of created holes

Fig.4 An example of reproduced color pictures

REFERENCES 1. D.Maydan, B.S.T.J. 50, 1761(1971). 2. L.F.Zernike, et. al., IEEE J.Quantum Electron. QE-13 15D(1977). 3. T.Shirai, et.al., J.Chem. Soc. Japan 84, 968(1963). 4. B.T.Kolomiets, Phys. stat. sol. 7, 359(1964).