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DIGITAL FIELD ION MICROSCOPY

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Due to environmental concerns, there is a trend to avoid the use of chemicals needed to develop negatives and to process photographic paper, and to use digital technologies instead. Digital technology also offers the advantages that it is convenient, as it enables quick access to the end-result, allows image storage and processing on computer, allows rapid hard copy output, and simplifies electronic publishing. Recently significant improvements have been made to the performance and cost of camera-sensors and printers. In this paper, field ion images recorded with two digital cameras of different resolution are compared to images recorded on standard 35 mm negative film. It should be noted that field ion images exhibit low light intensity and high contrast.

Field ion images were recorded from a standard microchannel plate and a phosphor screen and had acceptance angles of $\sim 60^\circ$. Digital recordings were made with a Digital Vision Technologies (DVT) MICAM VHR1000 camera with a resolution of 752x582 pixels (interfaced to a Scion Corp. LG-3 frame grabber with a resolution of 768x512 pixels), and a Kodak DCS 460 digital camera with a resolution of 3060x2036 pixels. Film-based recordings were made with Kodak T-MAX film rated at 400 ASA. The resolving power of T-MAX film, as specified by Kodak, is between 50 and 125 lines per mm, which corresponds to between 1778x1181 and 4445x2953 pixels, i.e. similar to that from the DCS 460 camera. The intensities of the images were sufficient to be recorded with standard f1:1.2 lenses with exposure times of less than 2 s. Many digital cameras were excluded from these experiments due to their lack of sensitivity or the inability to record a full frame image due to the fixed working distance defined by the vacuum system. The digital images were output on a Kodak Digital Science 8650 PS dye sublimation color printer (300 dpi). The film-based images were printed on Kodabrome II RC F4 photographic paper. All field ion micrographs presented in Fig. 1 were obtained from a Ni-19.0 at. % Al-2.6% Be specimen, heat treated for 8 h at 1100°C and 1 h at 800°C. The field ion micrographs were obtained with a specimen temperature of 50 K, with neon as the imaging gas, and at best image voltages of between 12 and 15 kV.

No significant differences were evident in the full frame micrographs shown in Fig. 1. It should be noted that the resolution in the full image obtained with the DCS 460 camera is limited by the printer. In contrast, the enlargements shown in Fig. 2, show significant differences. Pixelation is clearly evident in the enlargement of the image from the DVT camera. However, it should be noted that this degree of enlargement is rarely required in typical field ion microscopy applications. A comparison of the images obtained on the DCS 460 camera and the T-MAX film does not reveal a significant difference in resolution. A slight disadvantage of the digital cameras is that the dynamic range available is lower than that of film and that the sensors are subject to saturation. In addition, noise is apparent in the image. This smaller range makes the digital technology inferior to film and can be apparent in cases in which the field ion images contain regions of different intensity, for example due to crystallographic zone-contrast or contrast between different phases or solutes in the material. However, the quality of digital field ion images is comparable to that obtained with film in many typical applications.

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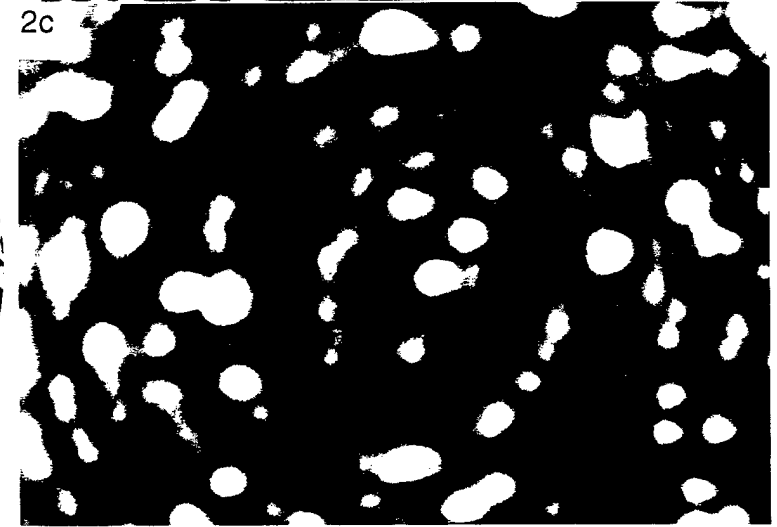
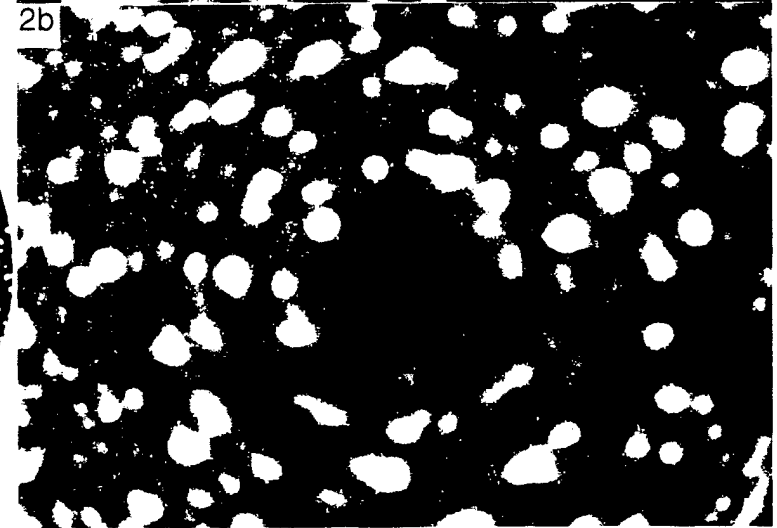
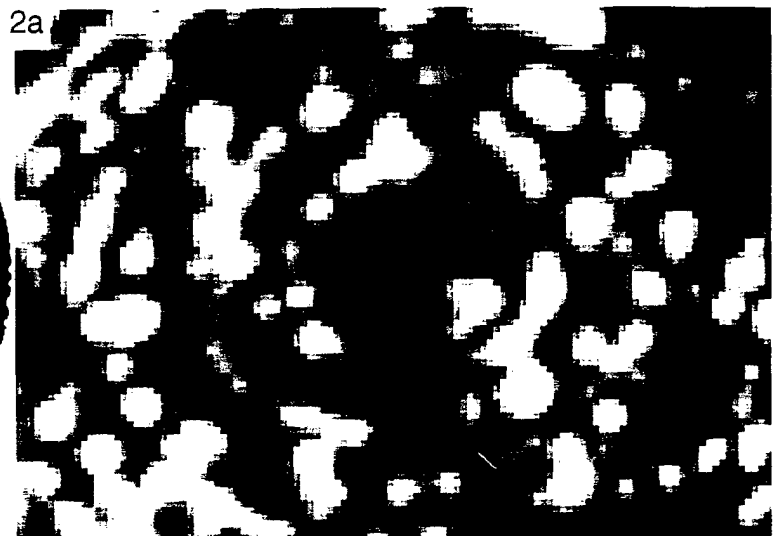
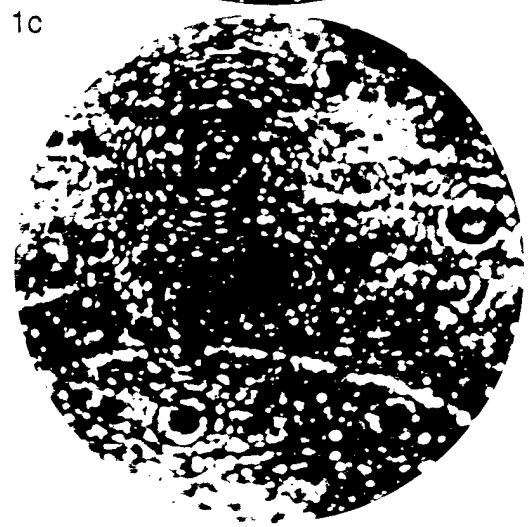
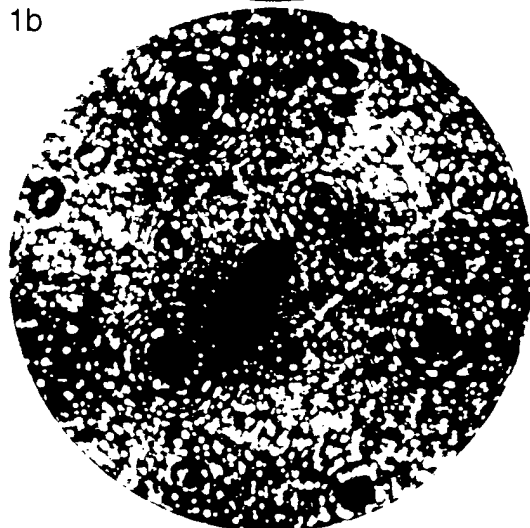
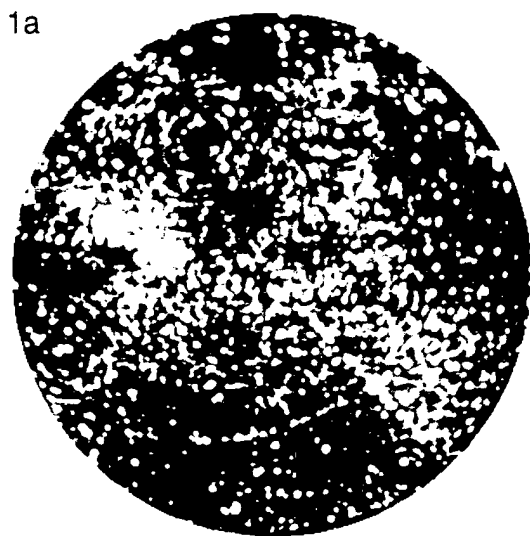


Fig. 1. Field ion micrographs from a Ni-Al+Be model alloy taken with (a) a DVT MICAM VHR1000 digital camera, (b) a Kodak DCS 460 digital camera, and (c) Kodak T-MAX film.
Fig. 2. Enlargements (5X) of Fig. 1.

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