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Evaluation of Fatigue Damage of Industrial Materials by Means of Diffraction Pattern Obtained by Synchrotron Radiation

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The relationship between fatigue damage and diffraction pattern was investigated using an image plate and synchrotron radiation. The relationship between them has been known about a hundred years ago. Taira et. al. studied widely on this theme and reported a lot of papers. Many other researchers also tried to study the problem using X-ray film, 0-dimensional counters such as a sintilation countor, 1-dimensinal counters such as PSPC(position sensitive proportional counter). A 2-dimensinal counter such as an image plate and a CCD are recently used widely in this field. But their application to evaluate fatigue damage of engineering materials are not so many yet.

In this study, the relationship between fatigue cycles and diffraction image change of Cr-V steel was studied using synchrotron radiation and an image plate. The material is used for the electric generator motors in which fatigue strength is one of the most important factors at the design. Synchrotron source is useful for obtaining clear diffraction patterns and optimum Bragg angle direction. 2D detector is useful for obtaining entire part of diffraction ring.

Figure 1 shows diffraction patterns obtained from specimens that are subjected to different fatigue cycles from 0 cycle (no damaged) to about 6500 cycles. It can be seen that the diffraction patterns changed to a little bit spotty pattern to uniform and low intensity pattern. The change will be related to dislocation density in each grains and their preferred orientation distribution.

Figure 2 shows the relationship between full width at half maximum (FWHM) and consumed fatigue life N/N_f (%), where N is fatigue cycle and N_f is that at failure. The true lines indicate data obtained from fatigue samples, and dotted lines indicate those obtained from annealed sample. It is seen that the FWHM increases against the fatigue damage.

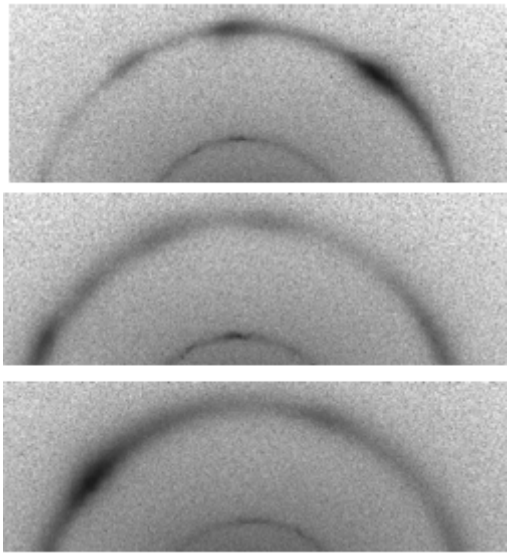

Fig. 1 200-Debye-Scherrer rings obtained from fatigued Cr-V steels using synchrotron radiation. (top:annealed, middle:N/N_f=10%, bottom:N/N_f=10%)

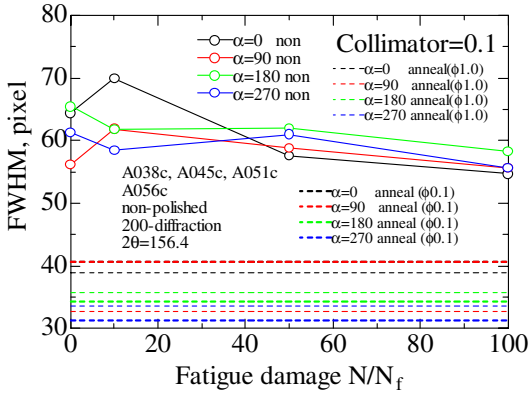

Fig. 2 Change of FWHM as a function of fatigue damage (N/N_f).

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