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Use of a monolithic SOI pixel detector to study rolling contact fatigue of railway rails

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In this study, a silicon-on-insulator (SOI) pixel detector was used to evaluate the fatigue damage of railway rails. For this purpose, the SOI pixel detector detected diffracted CrKα X-rays from a sample of a rail. Part of the Debye ring generated by the diffracted X-ray beams was obtained and was then analysed by using the principle of the X-ray stress analysis method. The rail from which the sample was taken had been used in service on a commuter line in Japan for about seven years. Fatigue cracks formed on the rail head. Tri-axial residual stress state and the full width at half maximum (FWHM) of the rail head were determined by the cosα method. The results of the experiment clearly showed the mapping results of the actual state on the rail head in terms of the formation of residual tri-axial stresses and white etching layers.
This research was undertaken because the risk of rail failures generally depends on defects in the rail material. Such defects form and grow due to the repeated loading of wheels of passing trains. The formation and growth of the defects are mainly influenced by bending stress, contact stress, thermal stress, and residual stress. Although residual stress in rails has been studied by X-ray and neutron methods, the effect of residual stress at the surface of the rail head has not been revealed in detail. In this study, to analyse the residual stress at the rail head in a wider area in detail, X-ray stress analysis was conducted by using a SOI pixel detector, and then data was quickly acquired. The application of a SOI pixel detector to X-ray stress analysis will be contributed to studying on the rolling contact fatigue of rails.

Keywords: SOI pixel detector, Debye ring, strain, residual stress, railway rail, rolling contact fatigue.

Submission declaration

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