welds and supports the observations of a change in microstructure due to cryogenic treatment, however there was no evidence of a change in the macro-hardness of the weld metal. Magnetic measurements using a magne-gauge were carried out on the weld metal and the readings shown in Table 4. The increase in magnetic readings in the treated samples confirms the formation of strain-induced martensites after cryogenic treatment. The formation of martensites in the weld metal induces compressive residual stress [5], which consequently increases fatigue crack initiation life.

3.2. Crack propagation analysis

The Paris power law [12] is:

$$\mathrm{d}a/\mathrm{d}N = C(\Delta K)^m, \tag{1}$$

where $\mathrm{d}a/\mathrm{d}N$ is the crack growth rate, ΔK is the stress intensity factor (SIF) range, and C and m are Paris constants. One of the formulae for stress intensity factors for the root of cruciform welded joints containing LOP was presented first by Frank and Fisher [13] and then improved [14] as:

$$\Delta K_{\mathrm{I}} = M_{\mathrm{k}}\Delta\sigma\left(\pi a \sec\frac{\pi a}{w}\right)^{\frac{1}{2}}, \tag{2}$$

where M_{k} is a correction for the local stress concentration of the weld:

$$M_{\mathrm{k}} = A_0 + A_1(2a/w) + A_2(2a/w)^2. \tag{3}$$

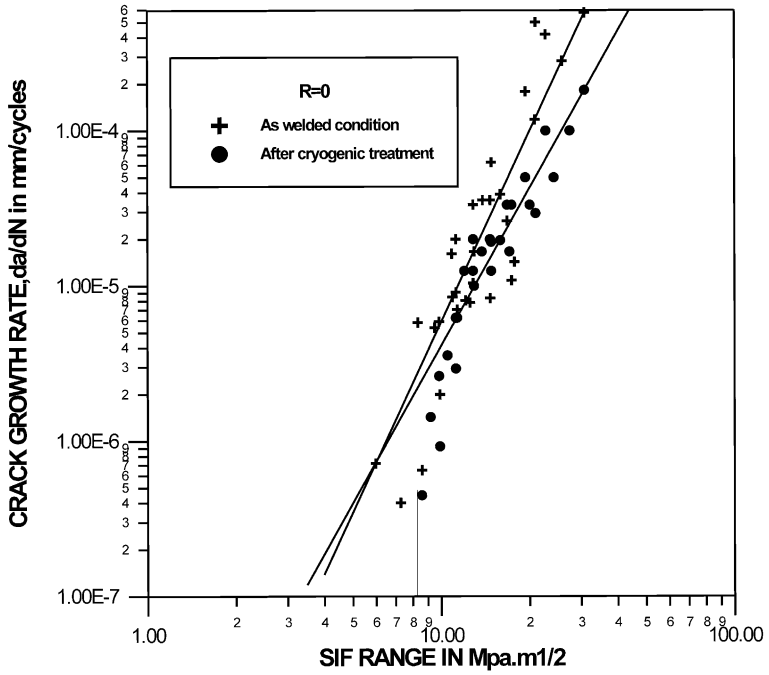

Fig. 5. Fatigue crack growth characteristics of treated and non-treated joints with threshold SIF, ΔK_{th} about 8.5 Mpa $\mathrm{m}^{1/2}$ in the case of treated joints.