SOME FEATURES OF THE EFFECT OF LOCAL CURRENT DENSITY INCREASE ON THE DESTRUCTION OF FLAT CONDUCTORS

Adamyan Yu.E., Alekseev D.I., Chernenkaya L.V., Krivosheev S.I., Magazinov S.G., Titkov V.V.

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Examples of our applications


2-for material pulse testing (Pm~0.5-2GPa)

S. Krivosheev, S. Magazinov, D. Alekseev High-speed deformation of copper samples with the use of magnet-ic pulse method MATEC Web of Conferences 145, 05006 (2018) NCTAM 2017 https://doi.org/10.1051/matecconf/201814505006

thick-walled single-turn solenoid
Lifetime estimate of a thin-walled solenoid

Magnetic pressure

Unit pulse strain

Crack start condition: $N \cdot e_1 = 0.4$

$N = 7$

Dimensions: $0.25 \times 0.25$ mm$^2$
Edge problems

\[ J(r) = J_0 \frac{r - R_1 / 2 + H}{\sqrt{(r - R_1 / 2)^2 + 2(r - R_1 / 2)H}} \]

2D quasi-static

current diffusion and heating aren't taken into account

Comsol
Multiphysics
3D simulation
ANALYSIS OF THE RESULTS

action integral

\[ I_n = \int_0^t J^2 dt \]

\[ I_{n2} = I_{n3} \quad I_{nBr} = 4.75 \times 10^{16} \]

\[ I_{n2,3} / I_{nBr} = 0.078 \]

1 - radius according 3D simulations
2,3 - experiment
ANALYSIS OF THE RESULTS

plastic flow

\[ V = V a \sqrt{1 - 2\mu_0 \frac{\sigma_s}{B_{m1}^2}} \]

\[ V a = B_{m1} / \sqrt{\gamma_0 \mu_0} \]

\[ \sigma_s = B_s^2 / 2\mu_0 \]

\[ r = \int_{t|B=B_s}^{t|B<B_s} V dt \]
tip crack fracture

$Lc\eta_0 = 1.0 \ mm$

$Lc\eta_0 = 2.0 \ mm$

$Lc\eta_0 = 3.5 \ mm$
the inhomogeneity of the distribution manifests itself on the size of the length of the defect

The simulation was carried out at the supercomputer centre “Polytechnic” with heterogeneous cluster HPC Tornado. The parameters of one node of the cluster: RSC Tornado – 2 CPU with 14 cores (2xXeon E5-2697v3 2.6 GHz 64 GB RAM).

Our thanks to FID GnbH for manufacturing microdefects
Conclusion

• Lifetime estimate of a magnet can be done considering plastic deformations accumulation.

• Plastic flow model for material in strong magnetic field can be used for description of crack type microdefect destruction on edge of current leading bus.

• The characteristic scale of Inhomogeneity of pressure distribution has the same size as the defect length.
• Crater Formation at the Tip of a Crack due to a Powerful Local Electromagnetic Field.

• [OBRAZOVANIE KRATERA V VERSHINE TRESHCHINY POD DEISTVIEM MOSHCNOGO LOKAL'NOGO ELEKTROMAGNITNOGO POLYA.]


• Effect of Electromagnetic Treatment on Fatigue Resistance of 2011 Aluminum Alloy M.A. Mohin1,a, H. Toofanny1,b, A. Babutskyi1,c, A. Lewis1,d, and Y.G. Xu2 Journal of Multiscale Modeling (2016) Vol. 7, Iss. 3, 1650004 Y01:10.1142/S1756973716500049

• TRANSFORMATION AND INTERACTION OF MICROCRACKS IN METAL UNDER HIGH-ENERGY PULSED ELECTROMAGNETIC FIELD K.V. Kukudzhanov1,2, A.L. Levitin № 2, 2016 PNRPU MECHANICS BULLETIN DOI 10.15593/perm.mech/2016.2.07

• Melting and cavity growth in the vicinity of crack tips subjected to short-duration current pulses(Conference Paper) Gallo, F.¹, Satapathy, S.²Email Author, Ravi-Chandar, K.³ IEEE Transactions on Magnetics Volume 45, Issue 1, January 2009, Номер статьи 4773635, Pages 584-586

• Simulation study on the fracture behavior of metallic materials subjected to short-duration electro-thermal loads(Article) Zhang, L.¹, Nie, J.²Email Author, Liu, J.³, Yang, L.³, Jin, Z.³ Gaodianya Jishu/High Voltage Engineering Volume 40, Issue 4, April 2014, Pages 1097-1103

• Et.al

• «Особенности магнитоимпульсного способа деформирования проводящих образцов» проф. Кривошеев С.И., доц. Адамьян Ю.Э.,асп. Алексеев Д.И., проф. Черненькая Л.В., инж. Магазинов С.Г., зав. каф. Титков В.В.