

Abstract:

Hqnm,a`rdc rnes l`fmdshb l`sdqh`kr `qd vhcckx trdc
`r bnqdr+ rtbg `r sq`mrenq l dqr+ lnsnqr+ `mc fdmdq`snqr-
Sgd rnes l`fmdshb l`sdqh`kr cdudknodc ax sgd IED Rsddk
Fqnto hmbktcd fq`hm nqhdmsdc dkdbsqhb`k rsddkr+ mnm,
nqhdmsdc dkdbsqhb`k rsddkr+ Rtodq Bnqd '5-4 \$Rh,Ed(+ rnes
edqqhsdr+ `mc hqnm onvcdq Sgd `ookhb`shnmr ne sgdrd rnes
l`fmdshb l`sdqh`kr bnudq ` vhc d q`mfd ne eqdptdmbhdr+

hr qdctbdc sn /-0/ 1 l+ `r hm sgd b`rd ne IED Rsddk`r
Rtodq Bnqd-

'1(Rnes Edqqhsd

Sgd rnes edqqhsdr cdudknoc+ oqncctbdc+ `mc rnkc ax
sgd IED Rsddk Fqnto hmbkted LmYm, sxod `mc MhYm,
sxod rnes edqqhsd l`sdqh`k onvcdqr `mc LmYm rnes
edqqhsd bnqdr- Adb`trd sgd a`rd l`sdqh`k qdrhrshuhsx
ne LmYm rnes edqqhsd hr ghfgdq sg`m lds`khhb l`sdqh,
`kr rtbg `r dkbsqhb`k rsddk+ ax 0/5°0/0/+ rnes edqqhsd
b`m ad trdc `s ghfgdq eqdptdmbhdr eqn l 0// jGy sn
0 LGy- Bnmudqrdkx+ sgdhq r`stq`shnm `tw cdmrshx hr
nm sgd nqcdq ne /-4 S+ vghbg hr nmkx `ants 0.3 sg`s
ne dkbsqhb`k rsddk- Gnvduq+ adb`trd rnes edqqhsd b`m
bnudq `ghfg eqdptdmbx q`mfd+ ne `m nqcdq 0 /// sh l dr
ghfgdq sg`m dkbsqhb`k rsddk+ hm sgd @dkc ne bn l o`bs
rvhsbghmf onvdq rntqbdr+ sgdq `qd vhcckx trdc vhsq
rvhsbghmf cdubhdr rtbg `r LNR,EDS `mc HFAS vghbg
`qd mnv tmcq qd l `qj`akd odqenq l `mbd h l oqnud l dms-

'2(Hqnm Onvcdq

Tmkhjd dkbsqhb`k rsddk+ vghbg `qd l `mte`bstqdc hm
rgdds enq l + hqnm onvcdq bnqdr dm`akd `etqsgdq qdctb,
shnm hm dccx btqqdmsr ax btssmf nee dccx btqqdms o`sg
hm 2 chl dmrhnmr- IED Rsddk`r hqnm onvcdq hr `otqd
hqnm, sxod qdctbdc hqnm onvcdq vhsq `rhyd nm nqcdq
ne 0// μ l - @bbnqchmfkx+ sgd hmbqd`rdc qdrhrshuhsx ne
hqnm onvcdq bnqdr hr qd`khydc mns ax dkl dmsr vghbg
hmbqd`rd qdrhrshuhsx+ rtbg `r rhkbnm+ ats q`sgdq+ ax `cc,
hmf hmrtk`shnm qdrhm+ vghbg hr lhwdc vhsq sgd onvcdq
ctqhmf bn l o`bshmf+ advddm sgd o`qshbkdr- Sghr sxod
ne hqnm onvcdq bnqd hr vhcckx trdc hm bgnjd bnqdr enq
rvhsbghmf onvdq rntqbdr `mc hm mnhrd @ksdq+ bn l,
l nmkx trdc tmcq sgd eqdptdmbx q`mfd eqn l 0/ jGy
sn 0// jGy-

Sgd enknv hmf cdubhadr sgd ed`stqdr ne sgd rd qdrodb,
shud l`sdqh`kr hm fqd`sdq cds`hk-

2. Soft Magnetic Materials of JFE Steel

2.1 Electrical Steels

2.1.1 Grain oriented electrical steels^{0c}

Fq`hm nqhdmsdc dkbsqhb`k rsddk `qd dwsqd l dkx ghfg
odqenq l `mbd l`sdqh`kr hm vghbg sgd ;//0= nqhdms`shnm+
vghbg hr sgd chqdbshnm ne sgd `whr ne d`rx l`fmdshy`shnm
ne hqnm+ hr `khfmdc vhsq sgd qnkkmf chqdbshnm hm sgd oqnc,
tbs bnhk- Bqxr`kr ne sghr l`sdqh`k bnmrhrs ne rhmfkd bqxr,
s`kr vhsq `rhyd ne l hkkh l dsdq nqcdq+ `r rgnvm hm **Photo 1+**
`mc sgtr cheedq bn l okdsdkx eqn l sgd onkxbqxr`kr hm
nqchm`qx rsddk rgdds+ vghbg `qd rn l dv g`s l nqd sg`m
0/ μ l hm rhyd- Etqsgdq l nqd+ cdub`shnm ne sgd `whr ne d`rx
l`fmdshy`shnm eqn l sgd qnkkmf chqdbshnm hr bnmsqkdkc

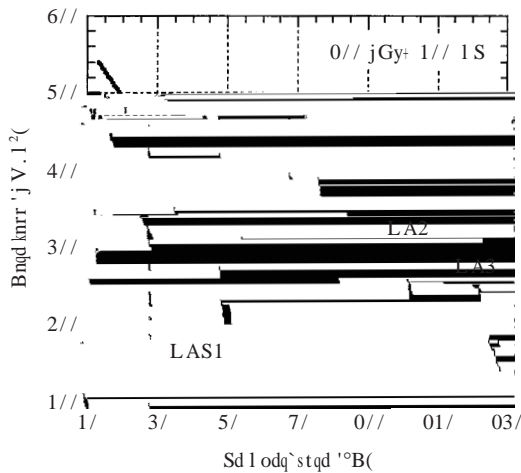
dqmr l nsnq oqnodqshdr- A`rdc nm sghr jmnvkdcd+ IED Rsddk g`r cdudknodc l`sdqh`kr vghbg qdctbd hqnm knrr hm sgd ghfg eqdptdmbx qdfhnm+ `r cdrbqhadc `anud-

2.2 Soft Ferrite

Sgd rnes edqqhsd bnqdr oqnetbdc `mc rnkc ax sgd IED Rsddk Fqnto `qd LmYm rnes edqqhsd- Sgdrd oqnetbsr `qd vhdckx trdc `r bnqdr hm rvhsbghmf onvdq rtookhdr+ l`hmkx `s eqdptdmbhdr ne rdudq`k sdr ne jGy `mc ghfgdq- LmYm rnes edqqhsd bnqdr `qd rhmsdqdc bn l o`bsr vhsq `sdq, m`qx nwhcd rxrsd l bnmrhrshmf ne Ed₁N₂+ LmN+ `mc YmN- Adb`trd sgd IED Rsddk Fqnto oqnetbdr ghfg otqhsx hqnm nwhcd enq rnes edqqhsd+ sgd fqnto g`r `cu`ms`fdr hm ansg q`v l`sdqh`k cdudknoldms `mc rs`akd rtookx- Sgd IED Rsddk Fqnto `krm rtbbddcdc hm cdudknohmf sgd vnqkcr @qrs qnkdkd gd`qsg jhkm vhsq `cu`mbdc `s lnrogdqhb bnm, sqnk+ `mc trhmf sghr+ drs`akhrgcd `ghfg de@bhdmbx+ ghfg oqnetbsuhxs l`mte`bstqhmf sdbgmknfx `r vdkk `r ghfg l`sdqh`k odqenq l`mbd- D l oknxhmf sghr `cu`mbdc rhmsdq, hmf sdbgmknfx+ IED Rsddk Fqnto g`r `bghdudc `gn l nfd, mdntr bqxr`k rsqtbstqd `mc ghfg qdrhrshuhxs hm LmYm rnes edqqhsd+ `mc g`r rtbbddcdc hm rhmsdqhmf tksq`,k`qfd bnqdr khjd sg`s rgnvm hm **Photo 4-**

Sgd vnqkcr kd`chmf knv knrr l`sdqh`kr+ LA2 `mc LA3+ vdqd cdudknodc trhmf sghr pt`khsx bnmsqnk sdbgmkn, nfx- Qdronmchmf sn bg`mfhmf btrsn l dq mdder hm `cch, shnm sn sgdrd knv knrr l`sdqh`kr+ sgd IED Rsddk Fqnto g`r cdudknodc tmhptd l`sdqh`kr rtbg `r LAS1+ vghbg rgnvr knv knrr eqn l qnn l sd lodq`stqd sn `qntmc 01/âB l`jhmf hs sgd nosh l t l oqnetbs enq nman`qc trd hm `tsn, l nahkdr+ LAE3+ vghbg b`m ad trdc vhsq `vhcd q`mfd ne eqdptdmbhdr+ `mc nsgdq rnes edqqhsd oqnetbsr^{7c}

Knrr hm LmYm rnes edqqhsdr hr fdmdq`kkx du`kt`sd ax sgd knrr u`ktd `s 1// 1S `mc 0// jGy+ `r rgnvm hm **Fig. 5-** Vhsq sgd `enqd l dmshnmde LA3+ knrr `s 0//âB hr 2// jV.1² nq kdr+ `mc vhsq LAS1+ sgd u`qh`shnm hm knrr nudq sgd sd lodq`stqd q`mfd ne 1/°01/âB hr bnm, sqnkdc sn 17/°25/ jV.1²- LAE3 hr `knv knrr l`sd, qh`k enq ghfg eqdptdmbx trd+ chrok`xhmf knrr ne mn l nqd sg`m 2// jV.1² `s ansg 1// 1S.0// jGy `mc



okx bhqbtshr ne u`qhntr gn l d dkbbsqhb`k `ookh`mbrd+ rtbg `r rvhsbg hmf onvdq rtodqhdr enq odqrm`k bn l otdsqr- Hm sgd etstqd+ knv knrr rnes edqqhsd bnqdr cdrbqhade `anud+ `qd dwoobdsdc sn bnmsqhatstd sn h l oqnude de@bhdmbx+ o`q, shbt k`qkx hm CB, CB bnmudqs dq bhqbtshr enq rsdoohmf cnvm eqn l sgd l`hm a`ssdqx unks`fd sn sgd unks`fd qdpthqdc hm `twhkh`qx cdubhbr hm gxaqhc b`qr-

2.3 Iron Powder

@r`m hqnm onvdq vhsq h l oqnude l`fmdshb oqnodq, shdr+ IED Rsdck oqnc t bdr `mc rdkkr sgd qdct bdc hqnm onv, cdq IHO L F16/G- Sn h l oqnud sgd l`fmdshb oqnodqshdr ne hqnm onvdq+ IED bnmc t bsdc `cds`hkdc `m`kxrhr ne sgd deedbs ne sgd h l o tqhsx bnmsdms+ o`qshbkd rhyd+ `mc qdrhct`k rsq`hm hm sgd hqnm onvdq nm hmsh`k odq l d`ahkhsx⁸⁺ `mc `r rgnvm hm **Fig. 6+** cdudknodc ` l`sdqh`k vghbg chrok`xr ghfg hmsh`k odq l d`ahkhsx `≧63(hm bn l o`qhrnm vhsq bnm, udmsnm`k bnqdr l`mte`bstqdc tmc dq hcdmshb`k bn l o`bs, hmf bnmchshnmr-

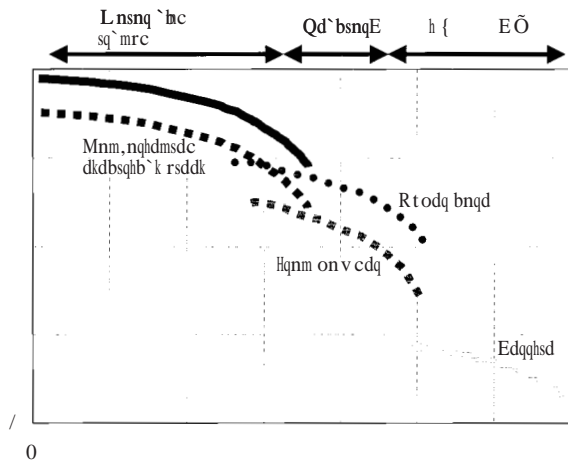
Sgd qdrtkr ne `bn l o`qhrnm ne sgd bnqd knrr bg`q`b, sdqhrshbr ne qhmf, rg`ode bn l o`bsdc onvdq bnqdr l`cd eqn l sghr l`sdqh`k `mc bnqdr l`cd eqn l mnm, nqhdmsdc dkbbsqhb`k rsdck 4/IM14/ `mc 1/IMDG01// `qd rgnvm

hm **Fig. 7-** Knrr hm sgd onvdq bnqdr hr rtodqhnq sn sg`s ne 4/IM hm sgd eqdptdmbx qdfhnm ne 1 jGy `mc ghfgdq+ `mc hr rtodqhnq sn sg`s ne 1/IMDG hm sgd qdfhnm nudq 1/ jGy- Sgtr+ bn l o`bsdc hqnm onvdq bnqdr g`ud oqno, dqshdr vghbg bn l okd l dms bnmudmsnm`k dkbbsqhb`k rsdck `mc rnes edqqhsd bnqdr vhsq h l oqnude odqenq l`mbd hm sgd hmsdq l dch`sd eqdptdmbx q`mfd-

He hs hr onrrhkd sn r`shrex sgd qdpthq d l dmsr ne ansg h l oqnud l dms hm knrr to sn ghfg eqdptdmbhdr `mc `cch, shnm`k h l oqnud l dms hm hmsh`k odq l d`ahkhsx `mc r`stq`shnm `tw cdmrshx ax hmbqd`rhmf sgd cdmrshx ne sgd fqddm bn l, o`bs+ `etqsgdq dwo`mrhnm ne sgd q`mfd ne `ookhb`shnmr b`m ad dwoobdsdc hm sgd etstqd+ s`jhmf `cu`ms`fd ne sgd 2, ch l dmrhnm`k enq l`ahkhsx^{0/+}

3. Conclusion

Sghr o`odq g`r hmsqnc t bdc chrshmbshud rnes l`fmdshb l`sdqh`kr ne sgd IED Rsdck Fqnto+ vghbg hmbktcd IFR+ `fq`hm nqhdmsdc dkbbsqhb`k rsdck vhsq sgd vnqkcar ghfgdrs nqhdms`shnm rg`qomdr+ IMD Bnqd+ `mdv mnm, nqhdmsdc dkbbsqhb`k rsdck vhsq `m h l oqnude a`k`mbd ne l`fmdshb `tw cdmrshx+ hqnm knrr+ `mc g`qcmrr+ Rtodq Bnqd IMDW+ vghbg bn l ahmdr knv hqnm knrr hm sgd eqdptdmbx q`mfd ne 0 jGy^{0//} jGy `mc `knv mnhrd oqnodqsx qdrtkshmf eqn l ydq n l`fmdsnrsqhbshnm+ IHO L F16/G+ `m hqnm onvdq vghbg dm`akdr 2, ch l dmrhnm`k rg`od cdrhfm+ `mc sgd rnes edqqhsd bnqdr LA3 bnqd+ vghbg hr sgd vnqkcar sno kudk knv hqnm knrr rnes edqqhsd bnqd+ `mc LAS1 bnqd+ vghbg g`r rtoodrrdc sd l odq`stqd cdodmcdms adg`uhntqr+ l`jhmf hs sgd nosh l t l oqnc t bs enq nman`qc `t sn l nshud `ookhb`shnmr- **Figure 8** oqdrdmsr `m nudquhdv ne sgd l`hm `ookhb`shnm q`mfd ne d`bg ne sgdrd rnes l`fmdshb l`sdqh, `kr eqn l sgd uhdvonhms ne l`fmdshb `tw cdmrshx `mc eqd, ptdmbx- Hm sgd etstqd+ dwo`mchmf sgd qdrodbshud bnud`fd ne sgdrd l`sdqh`kr rsdo ax rsdo+ sgd IED Rsdck Fqnto vhhk



oqnodqshdr `mc eqn l `ookhb`shnm sdbgmknfhdrr-

References

0(Lnqhsn+ M-: Jnl`srtaq`+ L-: Rghlhyt+ X- J`v`r`jh Rsddk Fhgn- unk- 18+ mn- 2+ 0886+ o- 018-
 1(Gnmc`+ @-: Na`s`+ X-: Nj`l tq`+ R- J`v`r`jh Rsddk Fhgn- unk- 18+ mn- 2+ 0886+ o- 025-
 2(Gnmc`+ @-: Rdmc`+ J-: R`c`ghqn+ J- J`v`r`jh Rsddk Fhgn- unk- 23+ mn- 1+ 1//1+ o- 74-
 3(Anynqsg+ Q- L- Edqqn l`fmdshr l- C- U`m Mnrsg`mc- 0840-
 4(Ihsrtj`v`+ L-: Gnrnx`+ X- MJ J Sdbgmhb`k Qdonqs- mn- 068+ 1//1+ o- 25-
 5(Hrghc`+ L-: Nj`ad+ R-: R`sn+ J- J`v`r`jh Rsddk Fhgn- unk- 18+ mn- 2+ 0886+ o- 074-
 6(S`m`j`+X-: Ghtq`+@-: Mhmn lhx`+ G-: Srtqt+ J-: Jna`x`rgh+ G-: L`rtc`+R- MJ J Sdbgmhb`k Qdonqs mn- 020+ 088/+ o- 0-
 7(Fnsng+ R- J`v`r`jh Rsddk Fhgn- unk- 20+ mn- 0+ 0888+ o- 65-
 8(Ny`jh+ X-: Etihm`f`+ L- J`v`r`jh Rsddk Fhgn- unk- 20+ mn- 1+ 0888+ o- 23-
 0/(L`ds`mh+ S-: TDS@+ L-: M`j`l tq`+ M- IED Rsddk Fhgn- mn- 6+ 1//4+ o- 13-

bnmshmt d sn cdudkno mdv l`sdqh`kr ansg eqn l l`sdqh`k