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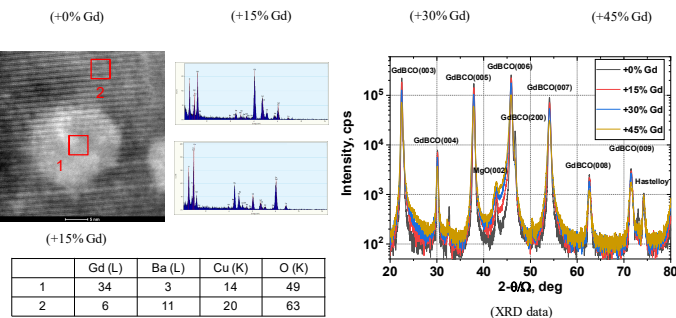
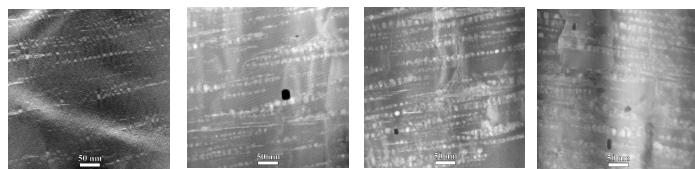
ABSTRACT

We prepared a series of 2G HTS wires with systematically varying gadolinium content in the GdBCO layer grown by pulsed laser deposition (PLD) and characterized them by transport I_c measurements over wide range of temperature (T) and magnetic field (H). The samples were fabricated using commercial production equipment at SuperOx and contained different concentration of Gd, starting from the standard production composition and with additions of 15, 30 and 45% of excess Gd. The critical current density was determined from hysteresis loops using PPMS in the 0-8 T field range and at temperature from 4.2 to 77 K. The resistivity curves of the samples were also measured using PPMS in the field range from 0 to 3 T in the orientation from $H||c$ ($\theta = 0^\circ$) to $H||ab$ ($\theta = 90^\circ$) at 30° increments. In this case, the curves were obtained by the 4-probe technique with a 100 mA measuring current. From these curves the irreversibility temperature, T_{irr} , was derived as the beginning of the resistive transition. We replotted the $T_{irr}(H)$ curves as irreversibility field lines $H_{irr}(T)$ and scaled those data using the relation for the effective field for rotated sample: $H_{eff} = H * \sqrt{\gamma^2 \sin^2 \theta + \cos^2 \theta}$. The activation energy, U_a , derived from the $\log(\rho/\rho_0)$ against $1/T$ plots was almost constant in the whole angular range, with a small peak at $H||ab$. The $U_a(\theta)$ curves looked similar for all samples; the activation energy as well as the critical temperature decreased with the increase of gadolinium content. The real (χ') and imaginary (χ'') part of magnetic susceptibility were measured in the 0-3 T field range. At high magnetic field the transition of χ' moves to low temperature and becomes wider for all samples. The maximum of χ'' also appreciably moves to low temperature. The obtained experimental results are evidence of different pinning structure mechanism in the samples.

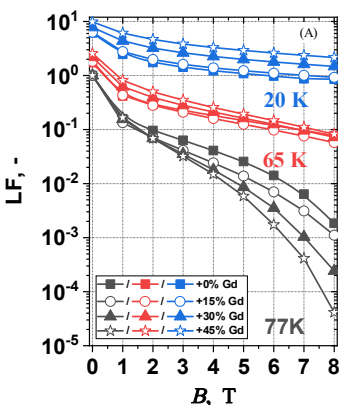
SAMPLES

| Sample # | Concentration of Gd % in CC | I_{c0} self-field, A | T_c , K | B_{q0} T |
|----------|-----------------------------|------------------------|-----------|---------------|
| 1 | +0%Gd | 625 | 93.3 | 0 |
| 2 | +15%Gd | 681 | 93.3 | 1.0 ± 0.2 |
| 3 | +30%Gd | 458 | 91.1 | 1.5 ± 0.4 |
| 4 | +45%Gd | 235 | 92.2 | 1.3 ± 0.6 |

MICROSTRUCTURE & XRD



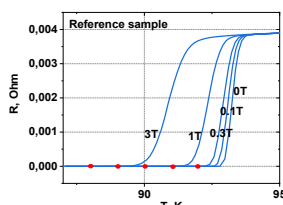
CRITICAL CURRENT



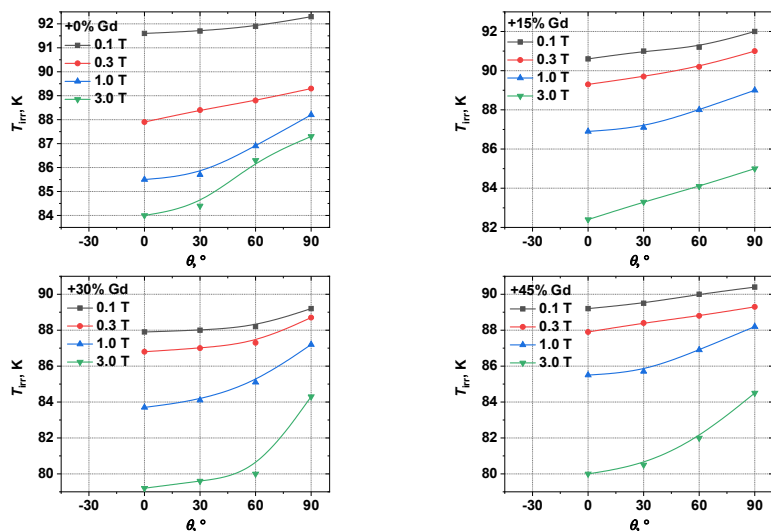
Field dependence of lift-factor (LF) at 77K, 65 and 20K for sample with different concentration of Gd (A). The critical current I_c (at 77K) for +0%Gd, +15% Gd, +30% Gd and +45% Gd is 681A, 625A, 458 and 235A correspondingly using 4-probe technique. The dependences of LF versus concentration of Gd for field 1T (B) and 8T (C). It is clearly observed that at 77K the LF is decreased with field, at 65K the LF is same for all samples even the field is increased and at 20K; the LF is increased for sample with 45% of exceed Gd. At $H=8T$ and $T=20K$ $LF=0.85$ for reference sample and 2.15 for sample with 45% of exceed Gd.

EXPERIMENTAL RESULTS

Typical curves of resistivity temperature dependence measured in magnetic fields up to 3 T. Red dots mark the irreversibility temperature as a beginning of transition with the 50 $\mu\Omega$ m criterion.

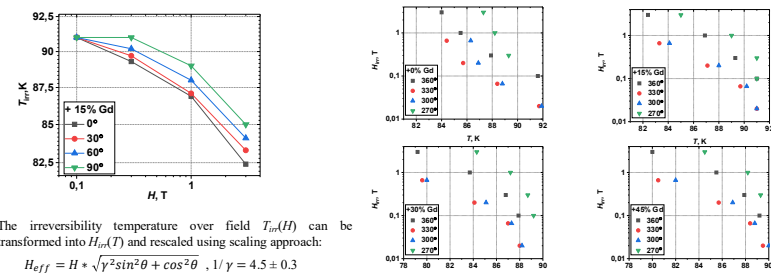


T_{irr} ANISOTROPY



Angle dependence of irreversibility temperature (T_{irr}) for reference sample and samples with additions of 15 (B), 30 (C) and 45 (D)% of excess Gd. $\theta^0 = B||ab$ and $90^\circ = B||c$.

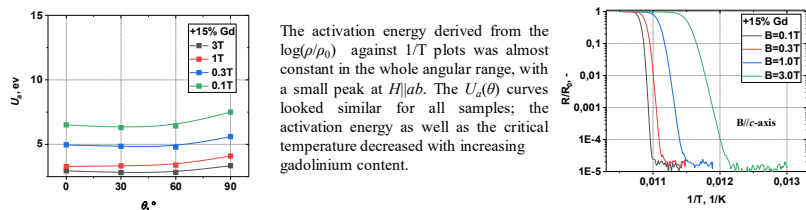
H_{irr} ANISOTROPY



The irreversibility temperature over field $T_{irr}(H)$ can be transformed into $H_{irr}(T)$ and rescaled using scaling approach:

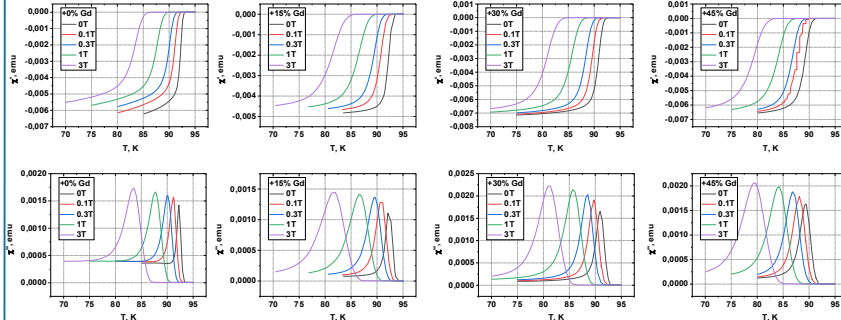
$$H_{eff} = H * \sqrt{\gamma^2 \sin^2 \theta + \cos^2 \theta}, \quad 1/\gamma = 4.5 \pm 0.3$$

ACTIVATION ENERGY



The activation energy derived from the $\log(\rho/\rho_0)$ against $1/T$ plots was almost constant in the whole angular range, with a small peak at $H||ab$. The $U_a(\theta)$ curves looked similar for all samples; the activation energy as well as the critical temperature decreased with increasing gadolinium content.

MAGNETIC SUSCEPTIBILITY



The real (χ') and imaginary (χ'') part of magnetic susceptibility were measured in the 0-3 T field range ($f=373$ Hz, $H_{ac}=5$ Oe). At high magnetic field the transition of χ' moves to low temperature and becomes wider for all samples. The maximum of χ'' also appreciably moves to low temperature. We observed that imaginary (χ'') part of magnetic susceptibility for pristine sample has residual value at low temperature that associated with high value of pinning (remanent magnetization).

CONCLUSIONS

- We systematically studied the resistive transition of 2G HTS wires with varying gadolinium content in the GdBCO layer grown by pulsed laser deposition (PLD).
- The absolute value of critical current at 77K is decreased with increasing of Gd concentration.
- The Lift-factor at 77K is decreased with field, at 65K the LF is same for all samples even the field is increased and at 20K; the LF is increased for sample with 45% of exceed Gd
- The anisotropy parameter of the samples, $1/\gamma$, of 4.5 ± 0.3 is close to the range typical for HTS of 5-7.
- At high magnetic field the real part (χ') of magnetic susceptibility moves to low temperature and becomes wider for all samples.
- The critical temperature decreased with increasing of Gd concentration only at +30% Gd.
- The maximum of imaginary part (χ'') of magnetic susceptibility also appreciably moves to low temperature.
- We observed that imaginary (χ'') part of magnetic susceptibility for pristine sample has residual value at low temperature that associated with high value of pinning (remanent magnetization).

ACKNOWLEDGEMENTS

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