superconductors $Y_1Ba_2Cu_3O_{7-\delta}$ and $Bi_2Sr_2Ca_1Cu_2O_8$. Irradiation with 3 MeV protons created point-like defects and energetic Sn-ions (580 MeV) created line-like defects. We studied the magnetization M(T,H,t) versus temperature T, time t, and field H ∥ c-axis and obtained the effective vortex pinning energy $U_{eff}(J,T)$ as a function of persistent current density J. For point-like defects, collective pinning (CP) theory provides that $U_{eff}(J,T) = (U_o/\mu)[(J_{co}/J)^{\mu}-1]$; the characteristic exponent μ has values of 1/7, 3/2 and 7/9 at progressively lower J-values. Experimental values of μ in proton-irradiated YBCO track this predicted dependence fairly well: as J decreases from its maximum accessible value, μ increases, passes through a peak with $\mu \approx 1.6$ at intermediate J's, then trends to values $\mu = (0.7 \pm 0.2)$ at low J. These experimental results clearly support the CP theory. Other studies of correlated disorder (linear defects) test recent theory, which predicts "entropy weakening" of the pinning potential at higher temperatures.

*Managed by Martin Marietta Energy Systems, Inc. under contract DE-AC05-840R21400 for the U.S. Dept. of Energy.

16:06

S21 9 Flux Pinning by Artificial Pins in Single Micron-Size Filament of NbTi.* X.S. Ling, J.D. McCambridge, D.E. Prober, Yale University, L.R. Motowidlo, B.A. Zeitlin, IGC Advanced Superconductors. --NbTi alloy is important for many applications. The present commercial process for creating pinning centers in NbTi wire uses α-Ti precipitates produced by thermal processing. The use of the artificial pinning centers (APC)[1] is an alternate approach. We report results of measurements on single micron-size filaments of APC wire. The issues of proximity-effect and the pinning summation problem in these structures will be discussed. Thin-film analogs of the APC structure are also being studied.
*Supported by Conn. Dept. of Economic Development, Grant #92G036 and by Intermagnetics General Corporation.
[1]L.R. Motowidlo, B.A. Zeitlin, M.S. Walker and P. Haldar, App. Phys. Lett. 61, 991 (1992).

Supplementary Paper

S21 10 Flux line Pinning by Competing Disorder. T. HWA* and D. R. NELSON, Harvard University, V. M. VINOKUR, Argonne National Laboratory. -- Localization of flux lines by columnar defects is investigated in the presence of point disorder. A 1+1 dimensional model is analyzed in some detail. When point disorder is weak, the glass transition is found to be of the Bose glass type. The Bose glass phase itself is marginally unstable to point defects, but only beyond an astronomically large crossover scale. Correlated disorder is always irrelevant when point disorder is very strong. The Bose glass transition is also studied in a small transverse magnetic field. Critical exponents for the commensurate-incommensurate transition which occurs in this case are derived using scaling arguments.
* Supported by NSF through the Harvard Materials Research Laboratory and Grants No. DMR-91-15491 and DMR-91-06237.

SESSION S22: HTSC: JOSEPHSON-JUNCTION ARRAYS
Friday afternoon, 26 March 1993
Room 310 at 14:30
D. Stroud, presiding

14:30

S22 1 Fractional constant voltage steps in parallel arrays of Josephson junctions. E. A. EARLY, A. F. CLARK, and R. L. STEINER, NIST, K. CHAR, Conductus, Inc. — In single Josephson junctions, the ac Josephson effect produces integrally quantized constant voltage steps. With junctions in parallel, additional fractional constant voltage steps can also be present. We have extended the model of a previous study[1] to include the effects of various parameters, such as the number of junctions, their inductances, and the normalized frequency, on the dependence of these constant voltage steps on magnetic field and microwave power. We have observed fractional steps in certain bi-epitaxial grain boundary high-T_c junctions, and an extensive comparison of the results of simulations with experimental results indicate that these grain boundary junctions are composed of multiple junctions in parallel.

[1]C. Vanneste *et al.*, J. Appl. Phys. 64, 242 (1989).

14:42

S22 2 Magnetic Hysteresis in the Flux-Dependent Critical Current of Parallel High T_c Josephson Junction Arrays.* J. H. MILLER, JR., Z. ZOU, S. CHOU, G. H. GUNARATNE, M. F. DAVIS, H. R. RAMPERSAD, and J. C. WOLFE, Texas Center for Superconductivity, University of Houston, Houston, TX 77204-5932 -- We have characterized the magnetic field-dependence of the total critical current of one-dimensional Josephson junction arrays [1], consisting of many $YBa_2Cu_3O_{7-x}$ bi-crystal grain boundary junctions in parallel. Dramatic hysteretic behavior is observed in plots of critical current *vs.* field, with pronounced "satellite" peaks being observed during reverse sweeps of the magnetic field. The observed hysteretic behavior is interpreted in terms of a novel critical state model, based on the Frenkel-Kontorova Hamiltonian. In the critical state, a plot of trapped flux per loop *vs.* position forms a "staircase," where the height of each step is equal to LI_c, where L is the self inductance of each loop and I_c is the critical current of each junction.

[1] J. H. Miller, Jr., G. H. Gunaratne, J. Huang, and T. D. Golding, Appl. Phys. Lett. 59, 3330 (1991).
*Supported by the State of Texas through the Texas Center for Superconductivity, the Robert A. Welch Foundation, and the Army Research Office.

14:54

S22 3 Generation peculiarities of the low-dimensional Josephson array. O.N.Gorshkov,I.L.Maksimov, A.Yu.Monakhov,I.Yu.Shalaev, Nizhny Novgorod Physical-Technical Institute --- Generation modes of the Josephson "cell" 2*2 under fixed total current are investigated both numerically and analytically.It is shown that the dynamical characteristics of the "cell" appreciably differ from the analogous ones of single Josephson junction. Namely, three essentially different generation regimes depending on the total current value , have been observed ; the correlation with the corresponding section of the voltage-current characteristics has been ascertained.The distinctive signal modulation was observed for the first time in the high current region $I>(I_{c1})_{max}$,I_{c1} is the critical current of the i-th contact (1<i<4). It is found that the modulation frequency ω_m, being essentially lower than the average generation frequency, decreases with current : $\omega_m \sim I^{-1}$. The features observed can be explained qualitatively on the basis of simple analytical model for 2*2 cell.

15:06

S22 4 Dimensional crossover in SNS(Nb-Au-Nb) Josephson junction arrays. Y.Jun, K.Ravindran, D.B.MAST,and R.S.Newrock. Physics Department, University of Cincinnati. ------ Dimensional crossover effects between two-dimensions and