

PACS Number 74.70Vy

Abstract Submitted
for the March 1990 Meeting of the
American Physical Society
12-16 March 1990

Sorting Category
Suggested Session:
High- T_C Superconductors

Electronic Properties of "n-type" High Temperature Superconductors as a Function of Synthesis and Processing. P.M. GRANT, M.E. LÓPEZ-MORALES* and R.J. SAVOY, IBM Almaden Research Center.-- We report studies on the resistivity, a.c. susceptibility and thermopower of ceramic $\text{Nd}_{2-x}\text{Ce}_x\text{CuO}_{4-y}$ and $\text{Nd}_2\text{CuO}_{4-y-x}\text{F}_x$ as a function of preparation and processing. We find that the temperature dependence of ρ in the normal state, the low-temperature shielding fraction given by χ_{ac} , and the sign and magnitude of the thermopower depend strongly on synthetic conditions. Usual calcination methods involving direct reaction of oxides of the constituent cations in a single step result in samples with non-metallic normal state resistivity, low bulk superconducting fraction, and a Seebeck coefficient which can change sign as a function of temperature. Using a two-step calcination followed by a long anneal time and rapid quenching, material is obtained with bulk superconducting fraction, metallic resistivity and negative thermopower.

*On leave from Instituto de Investigaciones en Materiales, UNAM

 Signature of APS Member

 Paul M. Grant

Name of APS Member

 IBM Almaden Research Center

Address

 San Jose, CA 95120-6099

Prefer Standard Session

Bulletin of the American Physical Society

Program of the 1990 March Meeting begins on page 160



16:06

K149 Electronic Properties of "n-type" High Temperature Superconductors as a Function of Synthesis and Processing. P.M. GRANT, M.E. LOPEZ-MORALES* and R.J. SAVOY, IBM Almaden Research Center. -- We report studies on the resistivity, a.c. susceptibility and thermopower of ceramic $Nd_{2-x}Ce_xCuO_{4-y}$ and Nd_2CuO_{4-y} as a function of preparation and processing. We find that the temperature dependence of ρ in the normal state, the low-temperature shielding fraction given by χ_{ac} , and the sign and magnitude of the thermopower depend strongly on synthetic conditions. Usual calcination methods involving direct reaction of oxides of the constituent cations in a single step result in samples with non-metallic normal state resistivity, low bulk superconducting fraction, and a Seebeck coefficient which can change sign as a function of temperature. Using a two-step calcination followed by a long anneal time and rapid quenching, material is obtained with bulk superconducting fraction, metallic resistivity and negative thermopower.

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16:18

K1410 Neutron Irradiation Effects of Un-doped and Doped Tl-Ba-Ca-Cu-O Superconducting Samples. J.M. Meason and Z.Z. Sheng, Department of Physics, R. Ulrich, Department of Chemical Engineering, University of Arkansas. -- Various un-doped and Ag- or Hg-doped Tl-Ba-Ca-Cu-O samples were exposed to different levels of neutron radiation and were compared to their non-irradiated counterparts by resistance measurement, ac susceptibility measurements, and x-ray diffraction analysis. Interesting differences between the irradiated and non-irradiated samples were observed.

16:30

K1411 Impurity Effect of S on Superconductivity in $YBa_2Cu_3SO_{6.5}$ J. T. Wang, Stanely Tsai, Willie Williams, and Saligrama SubbaRao Lincoln University, Lincoln University, PA 19352 A. Kebede and J. E. Crow Temple University, Philadelphia, PA 19122 -- We have studied the temperature dependence of resistivity, magnetization of $YBa_2Cu_3SO_{6.5}$ to determine the effect of the substitution of O by S. It has been found that the transition temperature T_c is about the same as $YBa_2Cu_3O_{7.5}$. It shows no isotopic effects; however, the susceptibility of $YBa_2Cu_3SO_{6.5}$ has remarkable difference from that of $YBa_2Cu_3O_{7.5}$. The curve of susceptibility $YBa_2Cu_3SO_{6.5}$ above T_c can well be fit by the Curie-like law.

*This work is supported by ONR Grant NO. N00014-89-J-3237.

16:42

K1412 Superconductivity in the Presence of Strong Paramagnetism: $(R_{0.2}Ca_{0.8})Sr_2(Tl_{0.5}Pb_{0.5})Cu_2O_y$ (R = Magnetic Rare Earth Element). K. Chen, Y.T. Huang, S.W. Lu, and W.H. Lee, Materials Research Laboratories, Industrial Technology Research Institute, Chunging, Hsinchu, Taiwan R.O.C. -- The electrical and magnetic properties of the monophasic polycrystalline superconductors $(R_{0.2}Ca_{0.8})Sr_2(Tl_{0.5}Pb_{0.5})Cu_2O_y$ (R = magnetic rare earth element), which crystallize in the $YBa_2Cu_3O_{7-x}$ -like tetragonal structure with space group $P4/mmm$, have been investigated. One interesting phenomenon is the observation of the strong paramagnetism induced by the low-field-cooled trapped flux. For the compounds with effective moment larger than $\sim 7 \mu_B$, the magnetic susceptibility became positive below T_c when the applied magnetic field was increased to ~ 2 Tesla. DC electrical resistivity measurements under these magnetic fields reveal the fact of incom-

pletely buried diamagnetic signal by the magnetic field induced paramagnetism.

* Supported by the Ministry of Economic Affairs, Republic of China, under contract no. 33B1000 to ITRI.

SESSION K15: HIGH T_c THEORY: ANYONS

Wednesday afternoon, 14 March 1990

San Simeon A Room at 14:30

D. Lee, presiding

14:30

K151 Anyon Superconductivity. Y-H Chen, F. Wilczek, E. Witten, B. Halperin, *Institute for Advanced Studies*; -- We investigate the statistical mechanics of a system of particles with fractional statistics (anyons) in 2+1 dimensions. We study the mean field theory of anyons. Based on the RPA, we study the superfluidity (or, superconductivity after coupling to electromagnetism) of anyon gas for statistical parameter $\theta = \pi(1 - 1/n)$. Large n approximation is taken to study the low energy excitations. We study the phenomenology of anyon superconductivity by mapping the response function from RPA to that of an effective lagrangian.

1 Y.-H. Chen, F. Wilczek, E. Witten, B. Halperin, *Int. J. Mod. Phys. B* **3**, 1001(1989).

14:42

K152 Collective Behavior of Anyons. C.B. HANNA, A.L. FETI and R.B. LAUGHLIN, *Stanford University* -- The undamped linearly-dispersing collective mode and the Meissner effect of the fractional-statistics gas are explained in terms of simple generalization of Lindhard screening. The collective-mode spectrum is obtained both variationally and in the random-phase approximation.

14:54

K153 Band Structure of the Flux Lattice. D.P. AROVAS* and F.D.M. HALDANE†, *University of California, San Diego* -- As an approximation to the many anyon problem, we have investigated the band structure of a charged particle in the presence of a two-dimensional lattice of flux tubes. Various features of the dispersion are sensitive to the arithmetic ratio p/q , where $\Phi = p/q \cdot hc/e$ is the flux per tube. For $p=1$, $q>2$, there appear to be $(q-2)$ extremely flat low-lying magnetic Bloch bands, reminiscent of a Landau level structure. Degeneracies and "flux smearing" are also discussed.

* NSF Presidential Young Investigator and Alfred P. Sloan Fellow.

** Supported in part by NSF: DMR-8901985.

15:06

K154 Noncommutative Geometry Instead of Nagaoka's Ground State and Fermi-Liquid Breakdown in Correlated Electron Systems. P. WIEGMANN, *University of California, San Diego* -- Arguments suggesting that in two dimensions the ground state of correlated electronic systems violates parity and time reversal are presented. It is shown that quasi-particles acquire fractional statistics and form an anyon gas.

15:18

K155 Superfluidity of the Lattice Anyon Gas and Topological Invariance. Eduardo Fradkin*, *Department of Physics, University of Illinois at Urbana-Champaign, 1110 W.Green St., Urbana IL 61801*. I consider a gas of "free" anyons with statistical parameter δ , with hard cores, on a two dimensional square lattice. I map this problem onto a gas of fermions coupled to a Chern-Simons gauge theory with coupling $\theta = \frac{2\pi}{2\delta}$. At the semiclassical level, the system is found to be equivalent to a gas of fermions, with the same density, in an average effective magnetic field $\frac{e}{2\pi}$. I consider the case in which an integer number of the Landau bands of the saddle point problem are completely filled. If $\delta = \frac{r}{m}$ and the density $\rho = \frac{r}{m}$, with m , r and q integers, the system is a superfluid, provided that q is larger than twice the largest common factor of m and r . If q is even and the system is half

Electronic Properties of "n-type"
High Temperature Superconductors
as a Function of
Synthesis and Processing

P. M. Grant

M. E. Lopez-Morales*

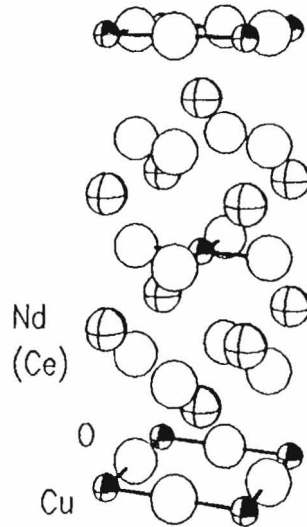
R. J. Savoy

IBM Almaden Research Center

* On leave from IIM-UNAM, Mexico City

Appearing in
Journal of Materials Research

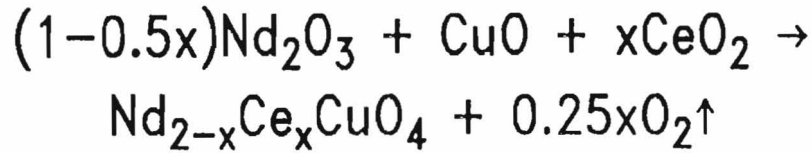
"n-type" High- T_c



- Nd_2CuO_4 Host
 - Long History ($> \text{La}_2\text{CuO}_4$)
 - Cu-O Planes: No Apical O
- 1988 SC Discovered (Tokura, et al.)
 - Doped with 4+ Cations
 - Negative Hall and TEP at 300K

Usual Synthetic Technique

One-Step Synthesis

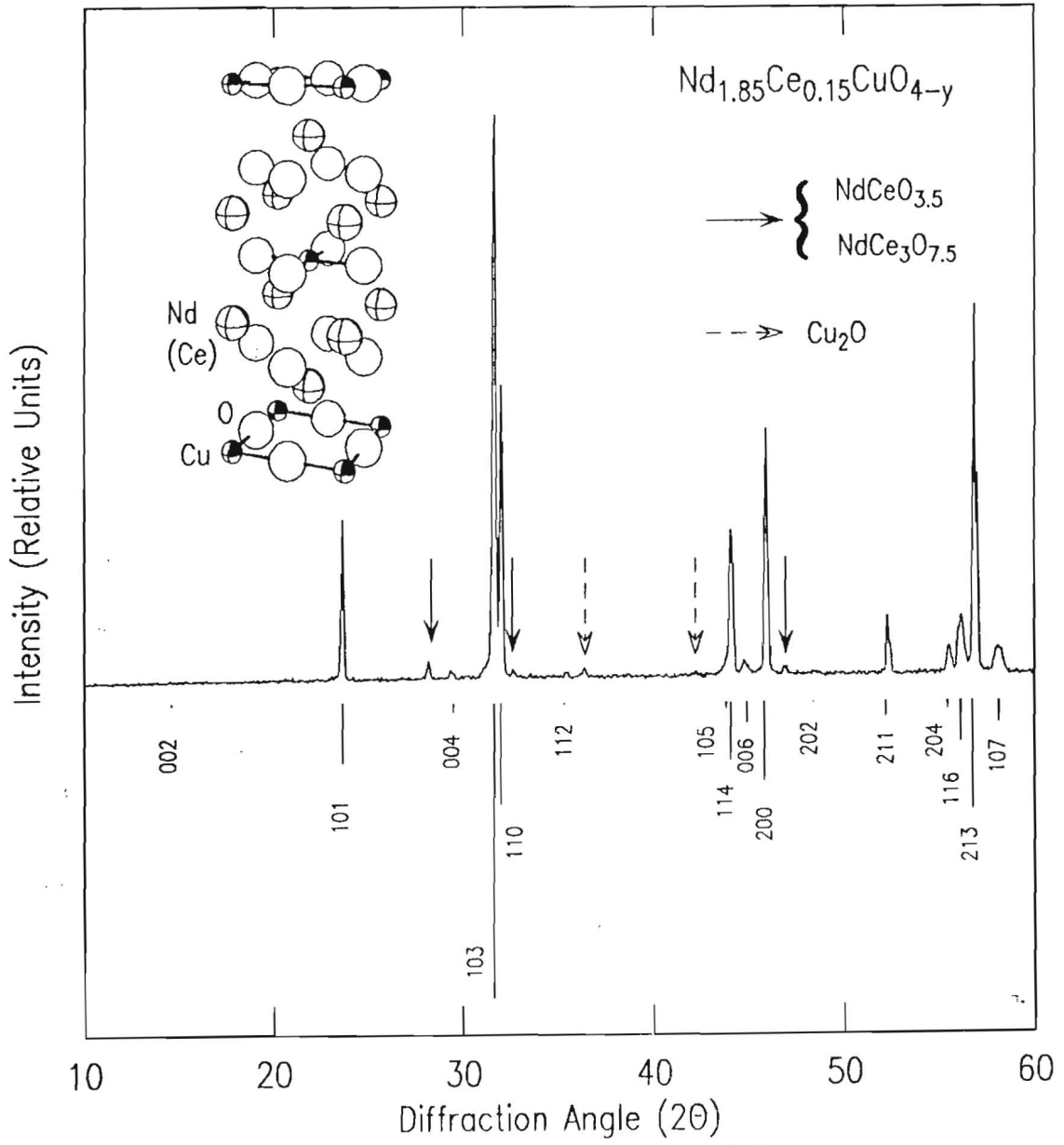


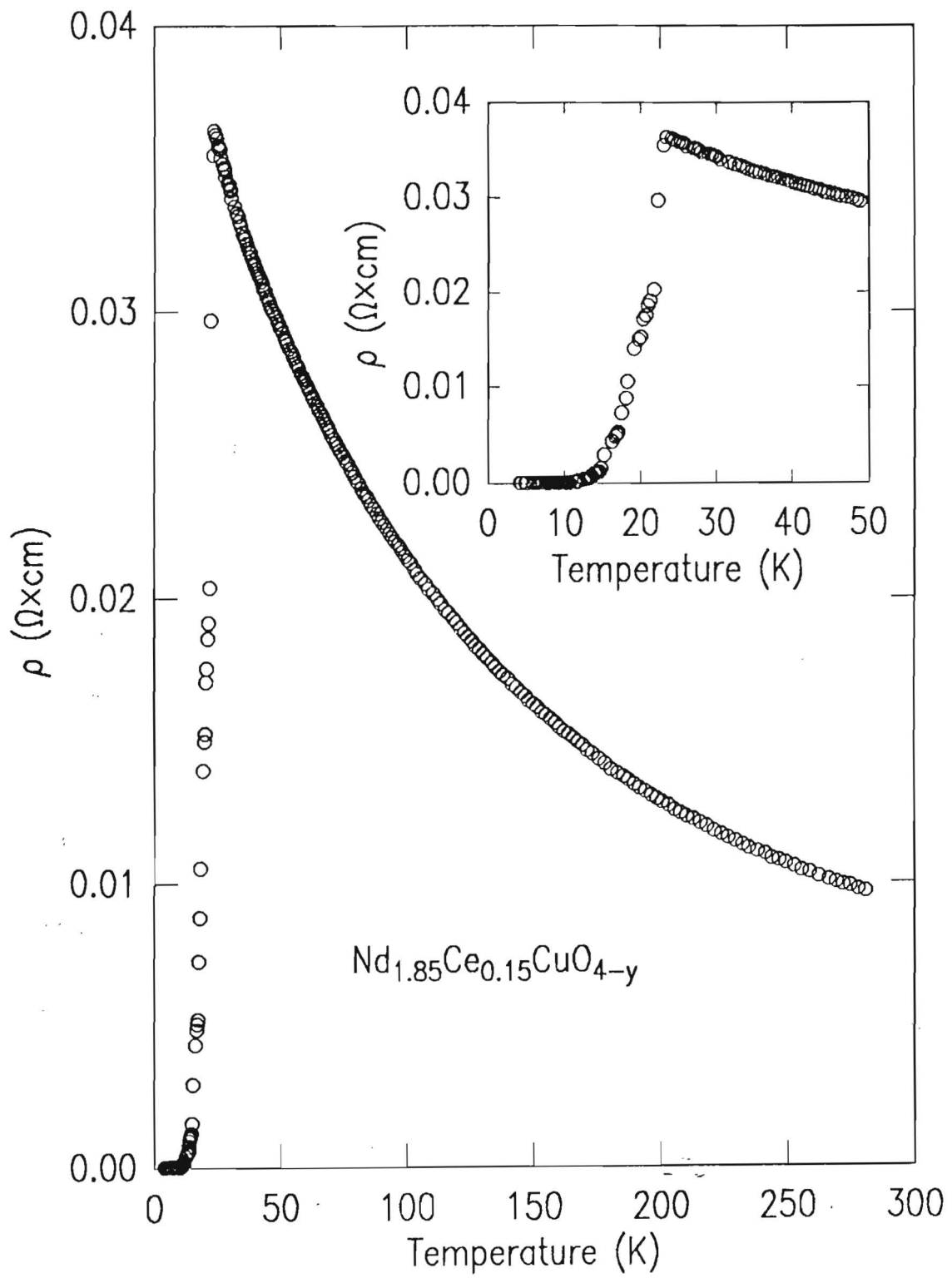
- Synthesis/Processing

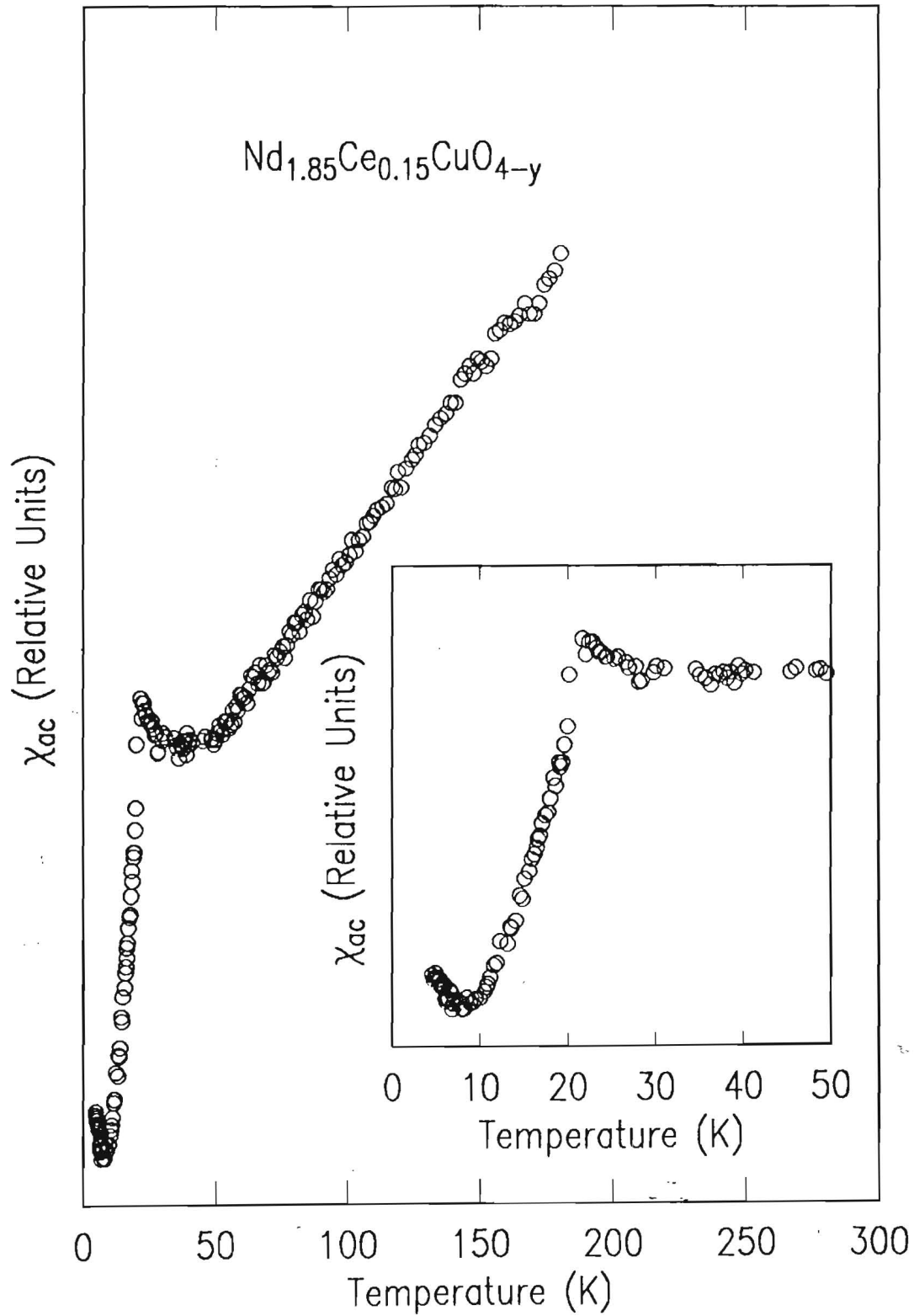
- Calcine at 950 °C
- Sinter at 1050–1150 °C
- Reduce under Argon
- Rapidly Quench

- Difficulties

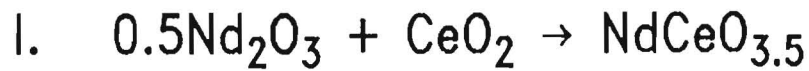
- Strong Ce–O Bond
- Slow Ce Diffusion
- High Temperatures Needed
- No Oxygen Reduction Control



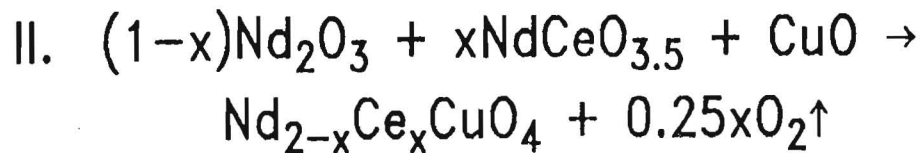




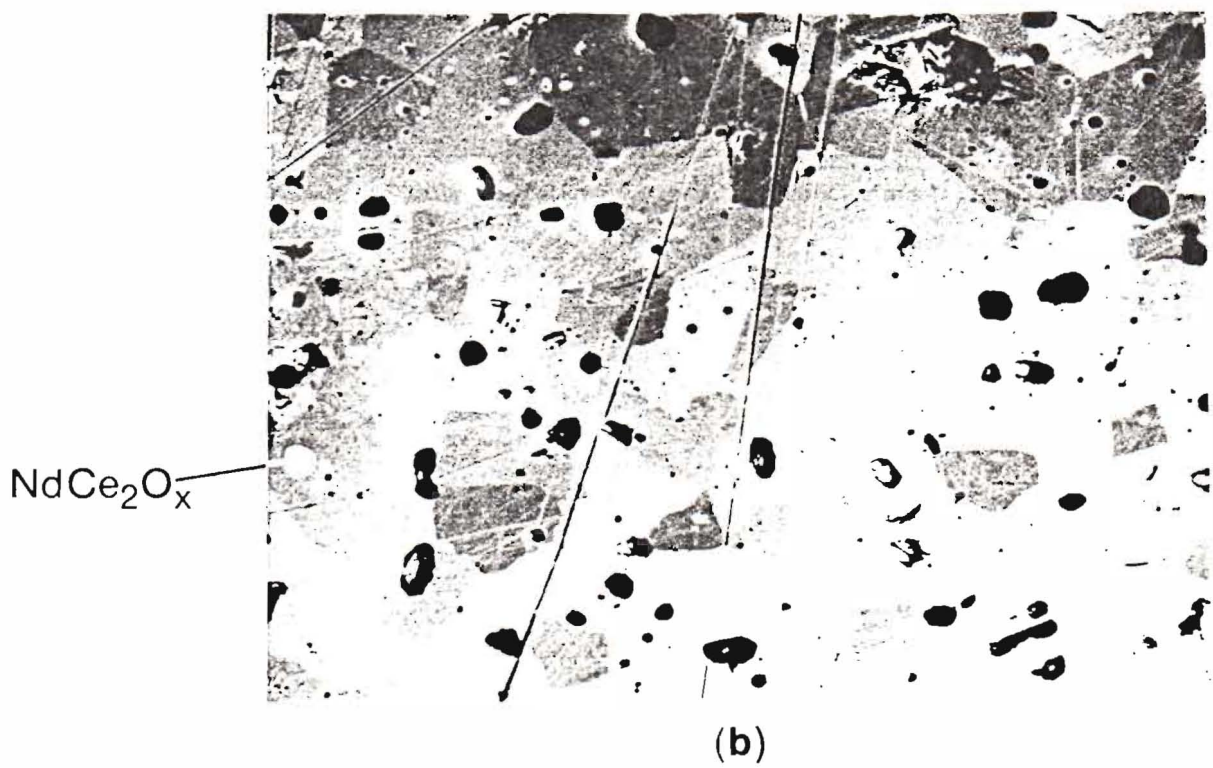
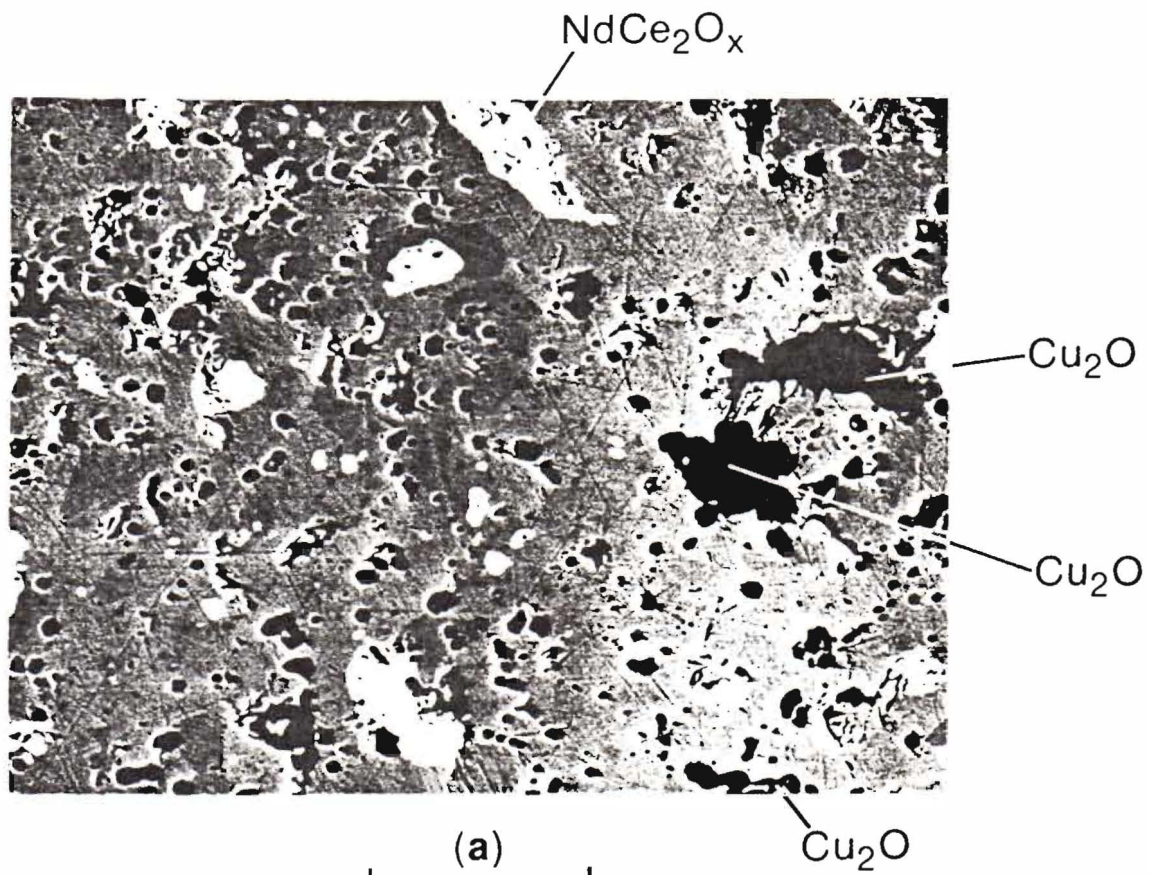
Two-Step Synthesis

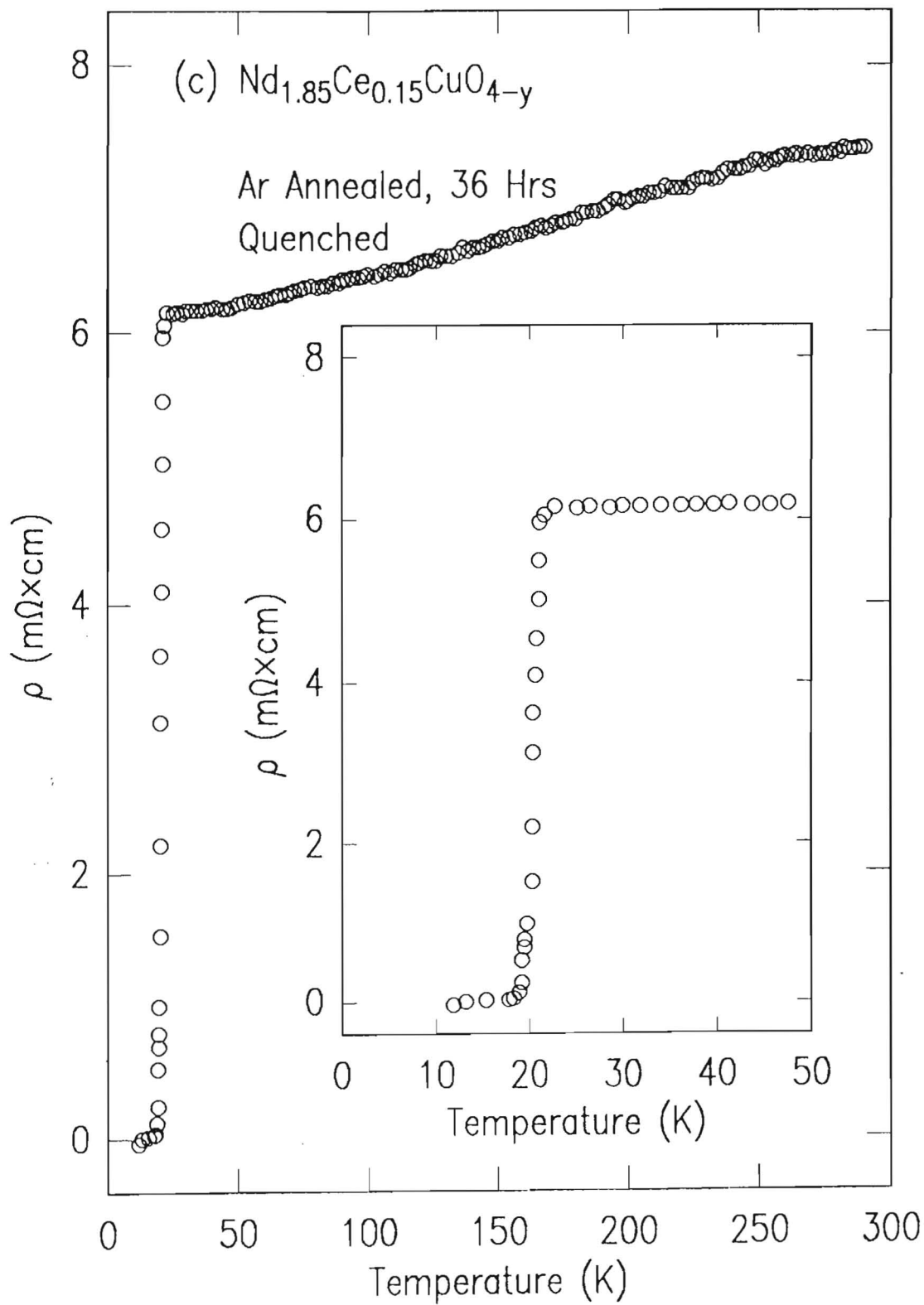


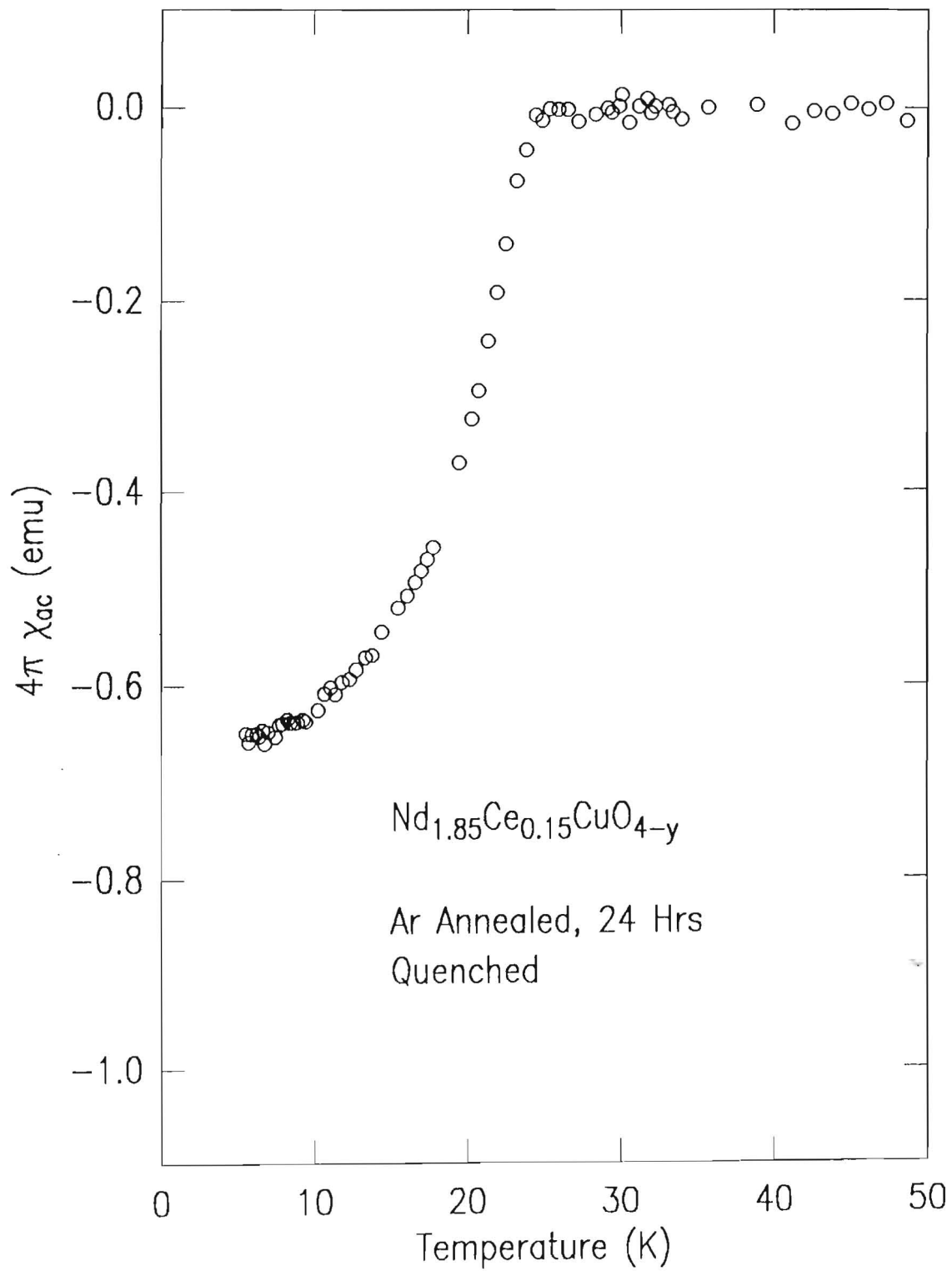
- Calcine at 1400 °C, 48 hrs, in air

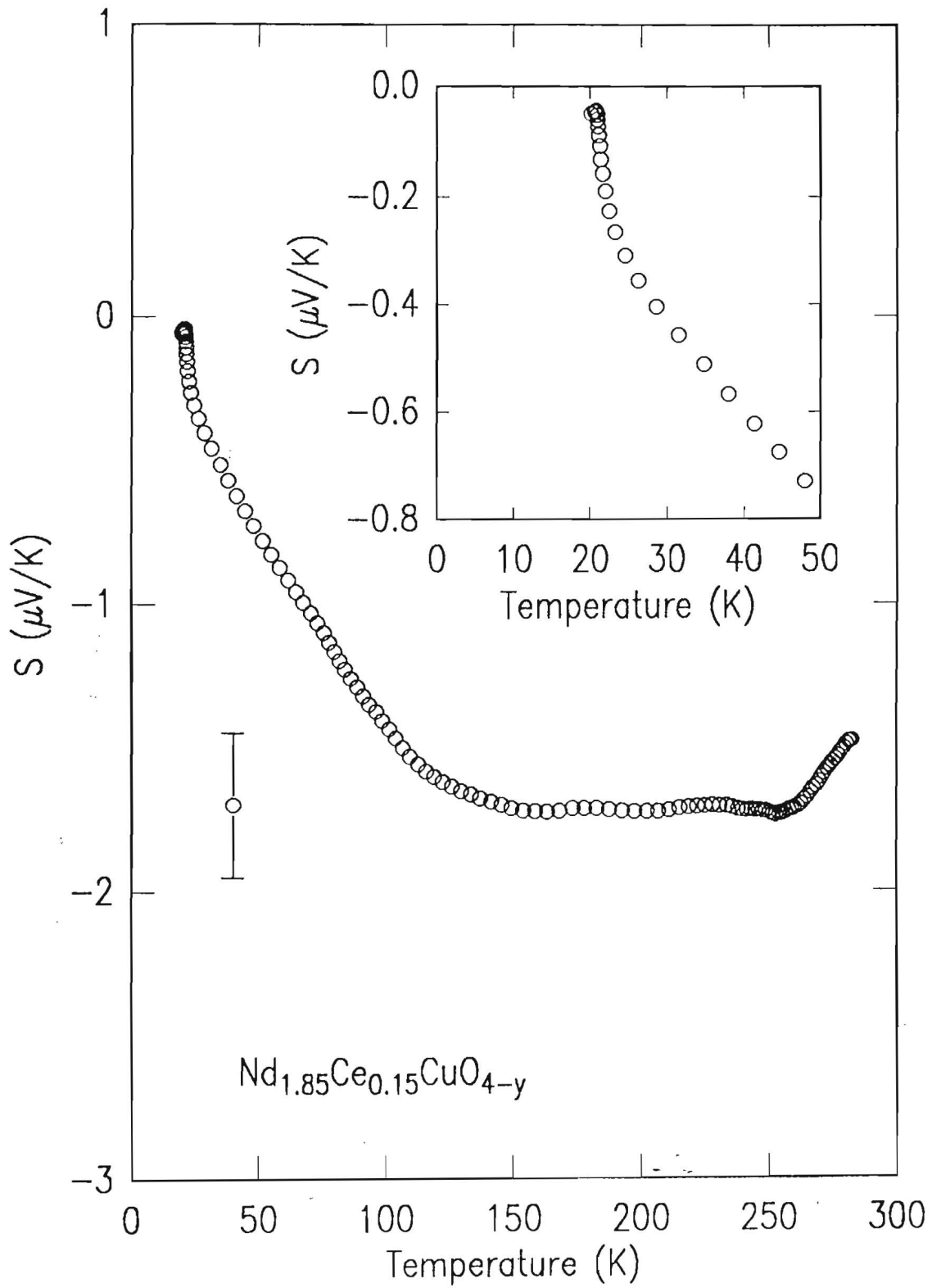


- Calcine at 980 °C, 24 hrs, in O₂
- Sinter at 1050 °C, 48 hrs, in O₂
- Anneal at 980 °C, 36 hrs, in Argon
- Quench to 25 °C, 30 sec, in Argon









Summary

- Successes

- Two-Step Method → Uniform Ce_x
- $d\rho/dT > 0$, $T > T_C$
- Narrow Transition Width
- High Diamagnetic Fraction
- Negative TEP, $T_C < T < 300$ K

- Unresolved Issues

- Oxygen Distribution
- Microstructure

