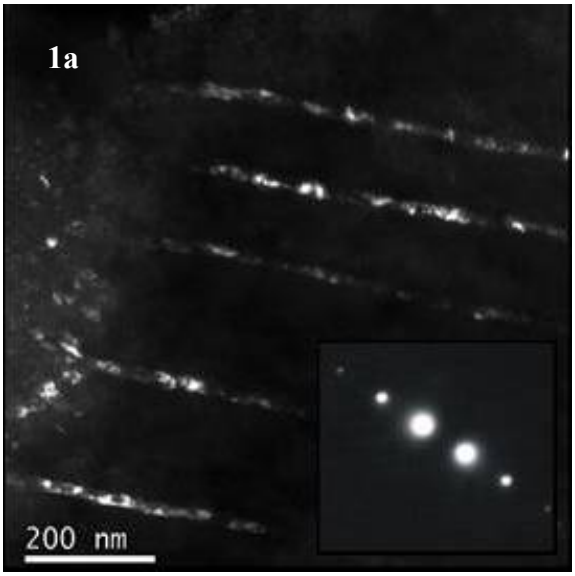
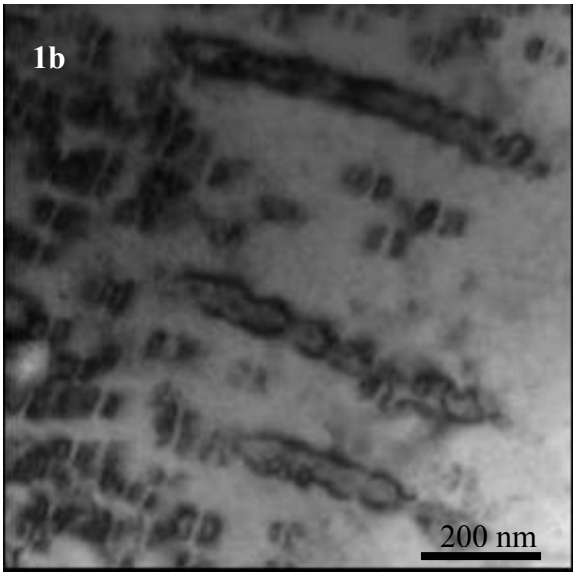
PHASE TRANSFORMATION PRODUCTS DEVELOPED UPON AGING IN DILUTED Cu-Co ALLOYS Ana Luiza Rocha (1), Guillermo Solórzano (1).and M. McCartney (2). (1)Department of Material Science and Metallurgy, PUC-Rio, Rua Marquês de São Vicente, 225 – Rio de Janeiro, 22453-900, RJ, Brazil: (2) Arizona State University ASU, USA. Email:anarocha@dcmm.puc-rio.br

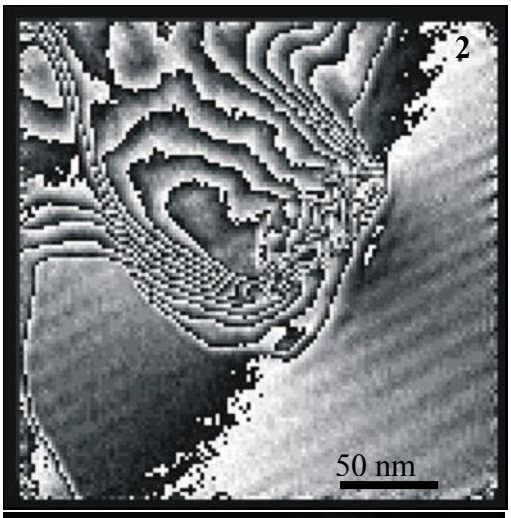
Diffusional solid-state phase transformations are traditional and fundamental approaches to taylor nano-scale microstructures. In general, two diffusional precipitation mechanisms are to be considered: lattice diffusion controlled and grain boundary diffusion-controlled. In case of the latter, which occurs in a number of alloy systems, such as Cu-Co, grain boundary precipitation takes place together with grain boundary migration, developing colonies of discontinuous precipitation (DP) products [1].The precipitation behavior of Cu-Co has been investigated for more than thirty years. The discovery of giant magnetoresistance (GMR), which opened new areas in magnetism and magnetic research at the nanoscopic scale, has given promising capabilities for information storage systems and sensor technology in this system [2]. This magnetic property has been driving the interest in developed electron holography in TEM by using these alloys [3]. The alloy composition we are currently investigating ranges from 1 to 4 at% Co, with the balance being Cu. The samples were homogenized about 30 minutes in the single phase region, quenched and then cold rolled (70%) and reanelled in order to promote recrystallization and generated a final grain size. Isothermal aging treatments were then conducted at temperatures of 500 to 700^0C. Thin specimens for TEM analysis were prepared following the conventional procedure consisting of slicing, mechanical thinning down to 150 microns and finally electrolytic thinning using the double jet technique in a solution composed, in volume, of 30% nitric acid and 70% methanol, kept at -20^0C. TEM investigation was then conducted using a Jeol 2010 microscope operating at 200 kV under diffraction contrast mode. In virtue of the grain size after recrystalization annealed have reached, in average, 100 microns in size, in the majority of the 3 mm sample discs the electron transparency region reach the center of grain, thereby far way from the grain boundaries (GB) of our interest. Evidence for DP was found under conditions of aging below the solubility limit. However, as reported in previous publication [4] discontinuous mode of precipitation did not occur at all GB but was restricted to a few GB in most specimens. In general, the rods are not perfect but there is a break down along its length. On the other hand, a regular separation of about 50 nm between the columns is maintained. An interesting feature of DP products observed in this system is related to the spheroidization of the rods into an alignment of coherent Co particles. In addition, under all aging conditions it is observed copious general precipitation of Co coherent particles through the matrix. In this work it is presented precipitation products resulting from a combination of DP of rods driving by migration boundaries together with conventional heterogeneous precipitation. Upon certain isothermal aging it was observed the developed of colonies of discontinuous precipitation products, figure 1a. Particles form as chains by coagulation of rods after discontinuous precipitation. These spheres are thought to form as a consequence of Rayleigh instability [1]. Previous studies have indicated that these homogeneous precipitates, in the order of 20 nm, are coherent with the matrix, displaying a typical strain field (Ashby-Brown) contrast, figure 1b [4]. Characterization of magnetic interactions, figure 2, is of great importance in nanoscale magnetic materials and depends sensitively on their shape, size and composition. The coexistence of nano-scale coherent precipitates together with robust incoherent Co precipitates (obtained by EDS) was observed after extended aging time; forming well developed faceted crystals of about 0.1 to 0.6 microns in size, figure 3. Depending upon the thermal conditions, the generations of domains in the order of 100 nm was also observed, figure 4. Current investigations complement precipitation processes studies based on polycrystalline samples with submicron grain size.

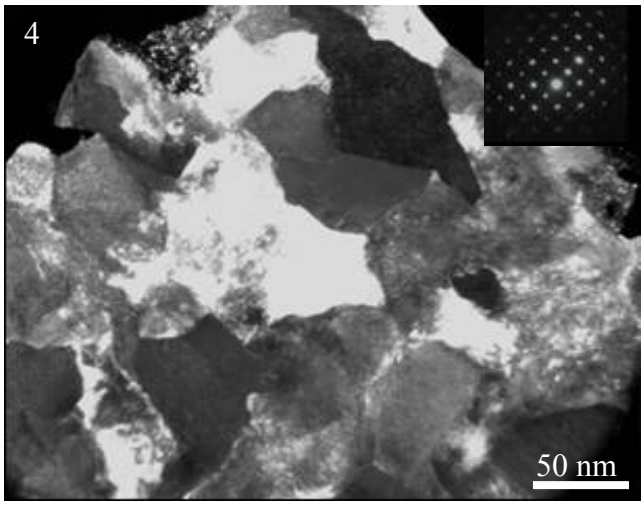
Acknowledgments:
This research is part of an Inter- American (CIAM) project supported by CNPq (Brazil) and NSF.

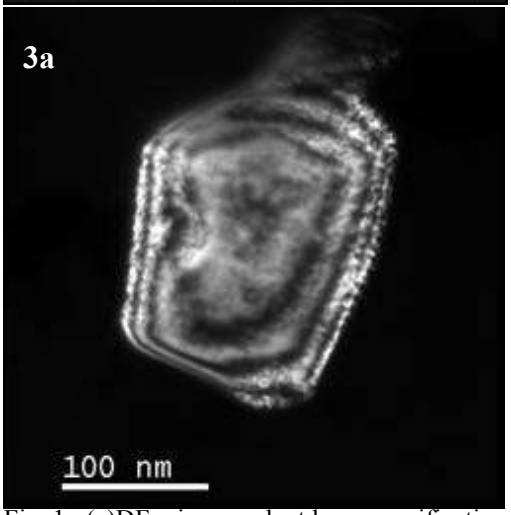
References:
[1] A. Perovic and G. R. Purdy,. Acta Metallurgica Vol.29, pp. 53-63, 1980.
[2] M. Takeda et al., Phys. Stat. Sol. (a) 168, 27 (1998).
[3] C. Beeli et al., Materials Characterization 42:175-182. (1999)
[4] A. L.Rocha et al. Proc. 13th European Microscopy Congress, edited by G. Van Tendeloo, pp. 273-274, 2004.











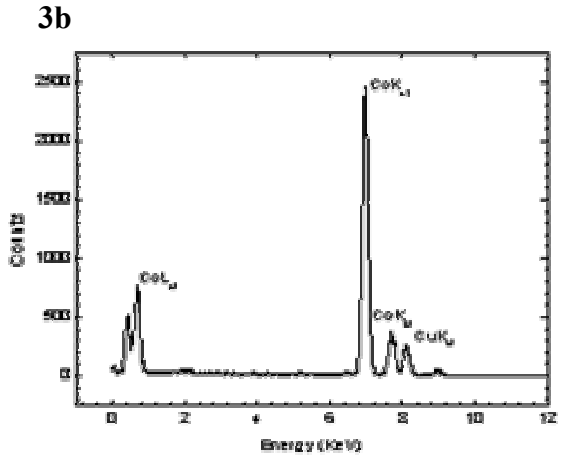


Fig. 1 –(a)DF micrograph at low magnification showing discontinuous precipitation in a Cu-Co alloy. Inserted, SADP and (b)BF image of rows of spherical particles displaying strain field contrast.
Fig. 2 – Off-axis electron hologram of reconstructed phase image showing typical magnetism in a Co particle.
Fig 3 – (a)DF micrograph of a well developed faceted Co crystals and (b) Corresponding EDS spectrum.
Fig 4 – DF image showing domains of about 100 nm in a Cu-3% Co alloy. Inserted, SADP