Supporting information

Annealed Cobalt-Carbon Nanocomposites for Room-Temperature Spintronic Applications

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Suppl. 1 – Profile of the deposits

The profiles of our as-grown and 300 ^{o}C annealed deposits were taken using atomic force microscopy (AFM). Figure S1 presents the overlapped profiles with thicknesses of around 28 and 30 nm, respectively. The cross-sectional area of the as-deposited material has decreased around

10% upon annealing at 300 °C during 10 minutes, which is consistent with our previous work using the $Co_2(CO)_8$ precursor.[1]

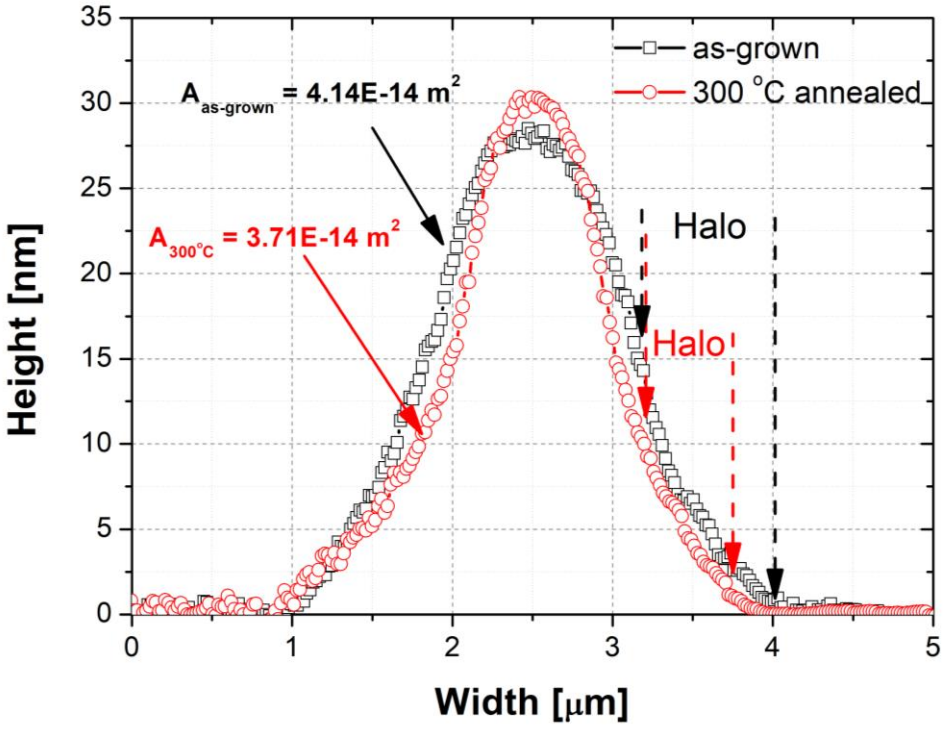

Figure S1. Profiles of the as-grown and 300 °C annealed deposits from $Co_2(CO)_8$ taken from AFM. The halo surrounding each wire is indicated. A slight shrinkage of the halo was observed upon annealing.

Suppl. 2 – MFM analysis

Figure S2 shows the MFM images of the 80 nm-thick as-deposited and 300 °C annealed discs with 8 μm in diameter. The non-rectangular shape of the hysteresis cycle shown in Figure 2(a) of the manuscript may be attributed to the nucleation and irreversible annihilation of vortices during the magnetization reversal process in a multidomain structure. Moreover, the grainy domain structure presented in Figure 4(d) for the rectangular deposit is also observed in the annealed disc.

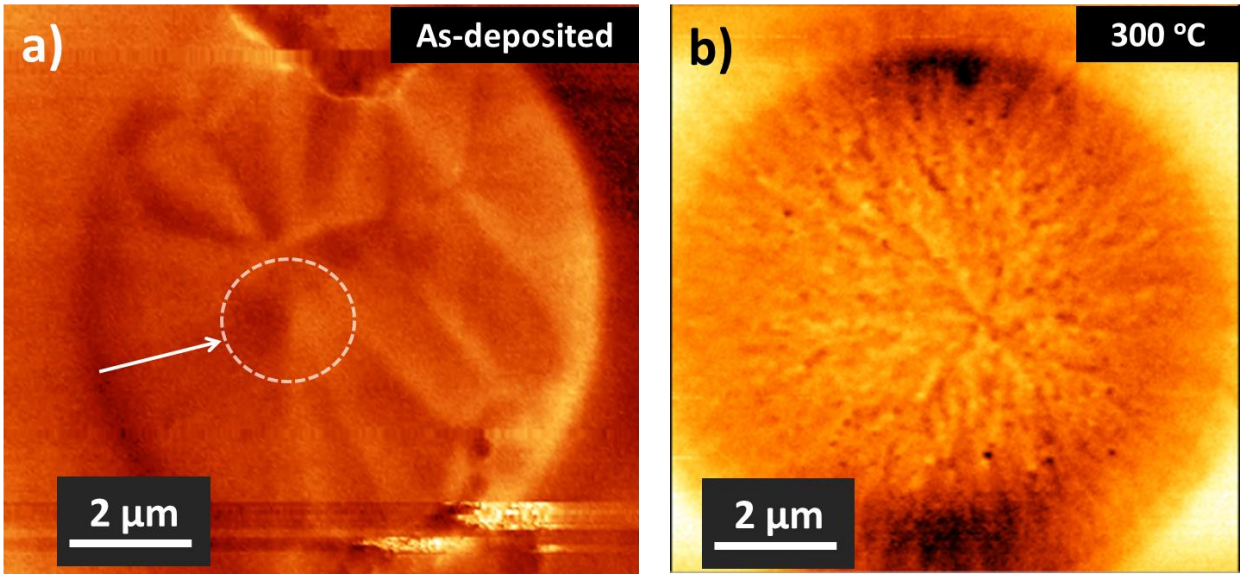

Figure S2. MFM images of the (a) as-deposited (54 at. % Co) and (b) 300 °C annealed (85 at.% Co) discs at remanence. The dashed circle in (a) shows one possible vortex surrounded by relatively large multidomain walls.

Figure S3 shows a 2 x 2 μm^2 MFM image in the center of our wire and it turns out to be formed by round-shaped granular distribution of domains. This image enhances the presence of both dark and bright spots, indicating a local perpendicular magnetic anisotropy (PMA) of granular structures of deposited Co-C.

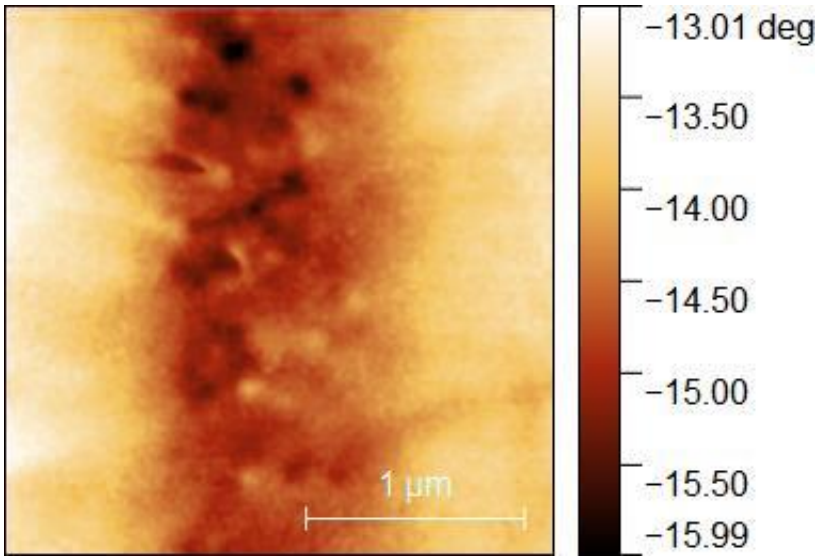

Figure S3. MFM image taken in the central part of the 300 °C annealed FEBID nanowire showing the round-shaped magnetic domains (bright and dark spots).

Suppl. 3 – Magnetic domain grain analysis

The magnetic domain structure of the 300 °C annealed nanowire shown in Figure 4(d) of the manuscript represents a complex well-defined round-shaped granular distribution of domains. The average size of those grains (58 ± 24 nm) were measured using ImageJ.[3] We measured the full width at half maximum (FWHM) of the profile of 20 different grains before adjusting the experimental distribution using the conventional Gaussian model (Figure S4).

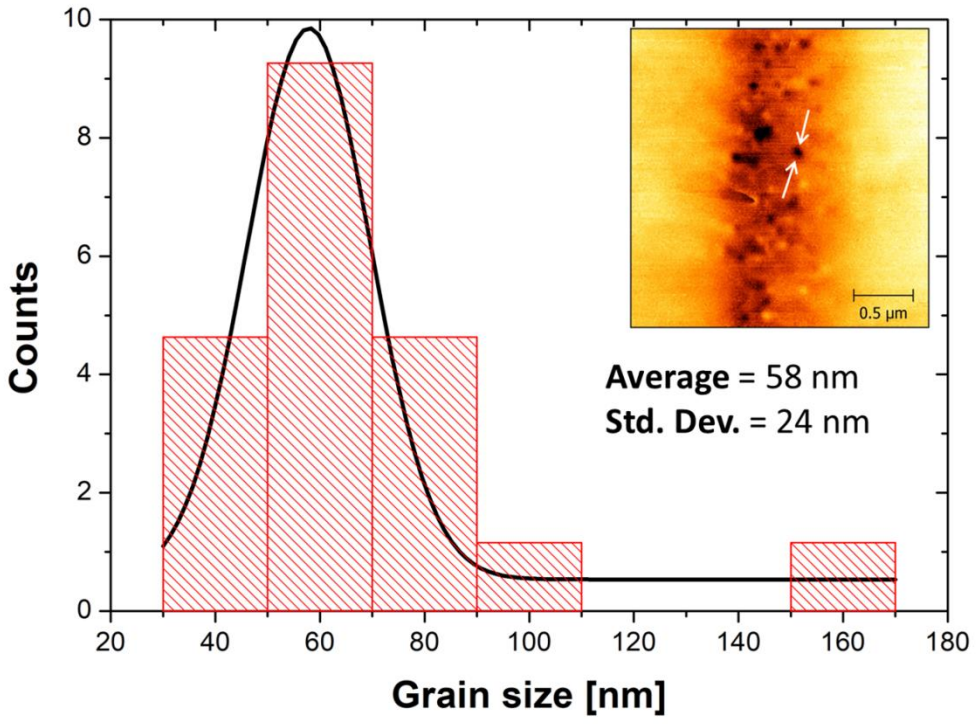

Figure S4. Magnetic grain size distribution observed in the MFM image of the 300 °C annealed material from $Co_2(CO)_8$ (inset). We found an average size of 58 ± 24 nm from the Gaussian distribution.

References

(1) Puydinger dos Santos, M. V.; Velo, M. F.; Domingos, R. D.; Zhang, Y.; Maeder, X.; Guerra-Nuñez, C.; Best, J. P.; Béron, F.; Pirota, K. R.; Moshkalev, S.; Diniz, J. A.; Utke, I.

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(2) Genoni, P.; Genuzio, F.; Menteş, T. O.; Santos, B.; Sala, A.; Lenardi, C.; Locatelli, A. Magnetic Patterning by Electron Beam-Assisted Carbon Lithography. *ACS Appl. Mater. Interfaces* **2018**, *10* (32), 27178–27187.

(3) Schneider, C. A.; Rasband, W. S.; Eliceiri, K. W. NIH Image to ImageJ: 25 Years of Image Analysis. *Nat. Methods* **2012**, *9* (7), 671–675.