**Supplementary Material**

Synthesis, textural and magnetic properties of doped and undoped CuO nanoparticles

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Figure S1.

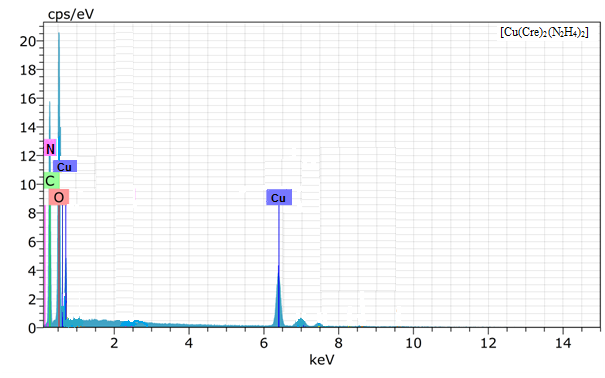


Figure S1 (continued)

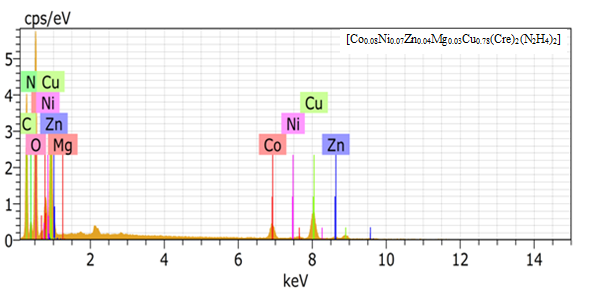
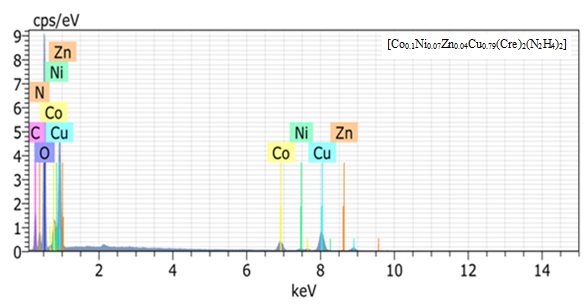


Figure S1. EDS spectra of the precursors-[Cu(Cre)2(N2H4)2], [Co0.1Ni0.07Zn0.04Cu0.79(Cre)2(N2H4)2] and [Co0.08Ni0.07Zn0.04Mg0.03Cu0.78(Cre)2(N2H4)2].

Figure S2.





Figure S2 (continued)



Figure S2. IR spectra of the precursors [Cu(Cre)2(N2H4)2], [Co0.1Ni0.07Zn0.04Cu0.79(Cre)2(N2H4)2] and [Co0.08Ni0.07Zn0.04Mg0.03Cu0.78(Cre)2(N2H4)2].

Figure S3.





Figure S3 (continued)



Figure S3. TG-DTA of the precursors [Cu(Cre)2(N2H4)2], [Co0.1Ni0.07Zn0.04Cu0.79(Cre)2(N2H4)2] and [Co0.08Ni0.07Zn0.04Mg0.03Cu0.78(Cre)2(N2H4)2].

Figure S4.

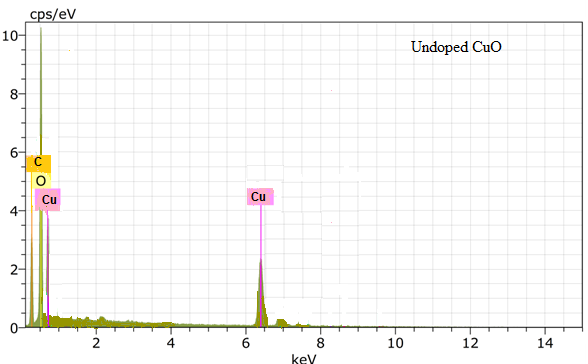


Figure S4 (continued)



Figure S4. EDS spectra of the undoped CuO, Co0.1Ni0.07Zn0.04Cu0.79O and Co0.08Ni0.07Zn0.04Mg0.03Cu0.78O nanoparticles.

Figure S5.





Figure S5 (continued)



Figure S5. FT-IR spectra of undoped CuO, Co0.1Ni0.07Zn0.04Cu0.79O and Co0.08Ni0.07Zn0.04Mg0.03Cu0.78O nanoparticles.

Table S1. Infrared analysis data of [Cu(Cre)2(N2H4)2], [Co0.1Ni0.07Zn0.04Cu0.79(Cre)2(N2H4)2] and [Co0.08Ni0.07Zn0.04Mg0.03Cu0.78(Cre)2(N2H4)2].

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| S. No. | Precursor | ν(N-H) cm-1 | νasy(OCO) cm-1 | νsym(OCO) cm-1 | Δν cm-1 | ν(N-N) cm-1 |
| 1 | [Cu(Cre)2(N2H4)2 | 3302 | 1612 | 1411 | 201 | 972 |
| 2 | [Co0.1Ni0.07Zn0.04Cu0.79(Cre)2(N2H4)2] | 3300 | 1610 | 1409 | 201 | 970 |
| 3 | [Co0.08Ni0.07Zn0.04Mg0.03Cu0.78(Cre)2(N2H4)2] | 3299 | 1606 | 1409 | 197 | 970 |

Table S2. TG-DTA of [Cu(Cre)2(N2H4)2], [Co0.1Ni0.07Zn0.04Cu0.79(Cre)2(N2H4)2] and [Co0.08Ni0.07Zn0.04Mg0.03Cu0.78(Cre)2(N2H4)2].

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| S. No. | Precursor | DTA Peak  (oC) | TG temp.  Range  (oC) | TG weight loss (%)  Obt. (calc.) | Final residue |
| 1 | [Cu(Cre)2(N2H4)2 | 243(-) | 200-300 | 84.9 (85.39) | CuO |
| 2 | [Co0.1Ni0.07Zn0.04Cu0.79(Cre)2(N2H4)2] | 250(-) | 200-300 | 85.1 (85.47) | Co0.1Ni0.07Zn0.04  Cu0.79O |
| 3 | [Co0.08Ni0.07Zn0.04Mg0.03Cu0.78(Cre)2(N2H4)2] | 261(-) | 200-300 | 85.3 (85.71) | Co0.08Ni0.07Zn0.04  Mg0.03Cu0.78O |

Table S3. ICP-AES data of undoped CuO, Co0.1Ni0.07Zn0.04Cu0.79O and Co0.08Ni0.07Zn0.04Mg0.03Cu0.78O nanoparticles.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| S.  No. | Sample | Co(2388)  % | Ni(2216)  % | Zn(2062)  % | Mg(2852)  % | Cu(2247)  % | Molecular mass (g) |
| 1 | Undoped CuO | - | - | - | - | 74.367 | 79.545 |
| 2 | Co0.1Ni0.07Zn0.04  Cu0.79O | 7.362 | 5.161 | 3.263 | - | 62.142 | 78.8173 |
| 3 | Co0.08Ni0.07Zn0.04  Mg0.03Cu0.78O | 5.195 | 5.097 | 3.208 | 0.860 | 61.257 | 77.7323 |

Table S4. XPS data of undoped CuO, Co0.1Ni0.07Zn0.04Cu0.79O and Co0.08Ni0.07Zn0.04Mg0.03Cu0.78O nanoparticles.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| S. No. | Element | Peak | Undoped CuO | Co0.1Ni0.07Zn0.04Cu0.79O | Co0.08Ni0.07Zn0.04Mg0.03Cu0.78O |
| 1 | Co2*p*  eV | 2*p*3/2 | - | 780.65 | 780.55 |
| 2*p*1/2 | - | 796.42 | 796.35 |
| S1 | - | 788.75 | 788.45 |
| S2 | - | 803.45 | 803.42 |
| 2 | Ni2*p*  eV | 2*p*3/2 | - | 855.55 | 855.35 |
| 2*p*1/2 | - | 873.55 | 873.45 |
| S1 | - | 861.25 | 861.24 |
| S2 | - | 881.75 | 881.70 |
| 3 | Zn2*p*  eV | 2*p*3/2 | - | 1021.51 | 1021.03 |
| 2*p*1/2 | - | 1045.53 | 1045.52 |
| 4 | Mg1*s*  eV | 1*s* | - | - | 1303 |
| 5 | Cu2*p*  eV | 2*p*3/2 | 933.82 | 934.48 | 934.52 |
| 2*p*1/2 | 954.40 | 954.58 | 954.48 |
| S1 | 942.71 | 943.30 | 943.40 |
| S2 | 962.52 | 962.52 | 962.52 |
| 6 | O1*s*  eV | 1*s* | 530.1, 531.2 | 530.12, 531.20 | 531.0 |
| 7 | C1*s*  eV | 1*s* | 285.3 | 285.10 | 285.5 |

Table S5. BET surface data of undoped CuO, Co0.1Ni0.07Zn0.04Cu0.79O and Co0.08Ni0.07Zn0.04Mg0.03Cu0.78O nanoparticles.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| S. No. | Sample | BET surface area  SBET (m²/g) | Surface area of pores SBJH  (m²/g) | Pore volume  VBJH  (cm3/g) | Average  pore  diameter  DP (BJH) (nm) | Average  particle  size DBET (nm) |
| 1 | Undoped CuO | 41.362 | 55.496 | 0.053 | 3.82 | 22.9 |
| 2 | Co0.1Ni0.07Zn0.04Cu0.79O | 22.185 | 30.902 | 0.046 | 5.95 | 42.8 |
| 3 | Co0.08Ni0.07Zn0.04Mg0.03Cu0.78O | 15.181 | 26.439 | 0.039 | 5.90 | 62.6 |