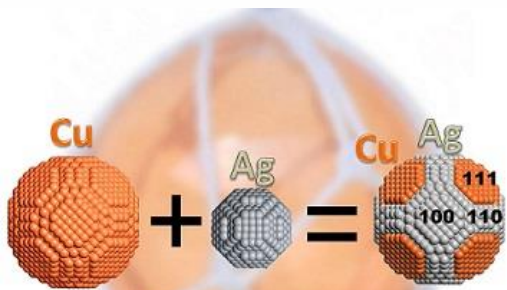


# Toxicological effects of CuO on the Developmental Effects of Sea Urchin and Zebrafish Embryos

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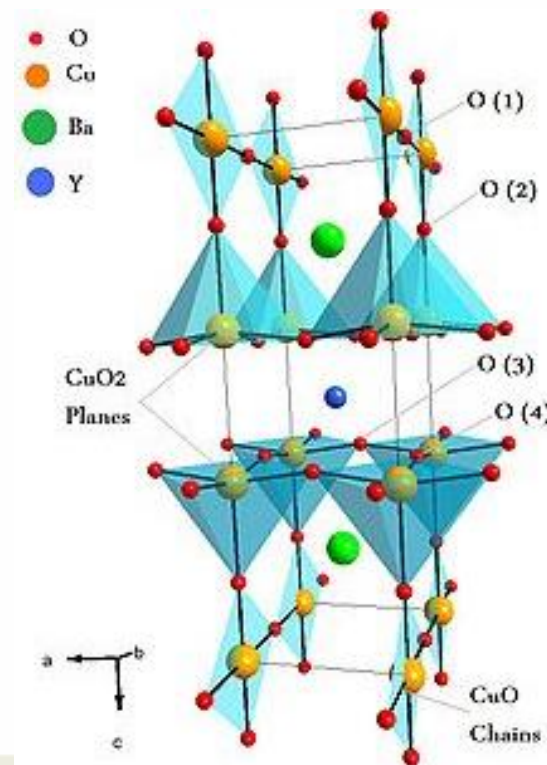
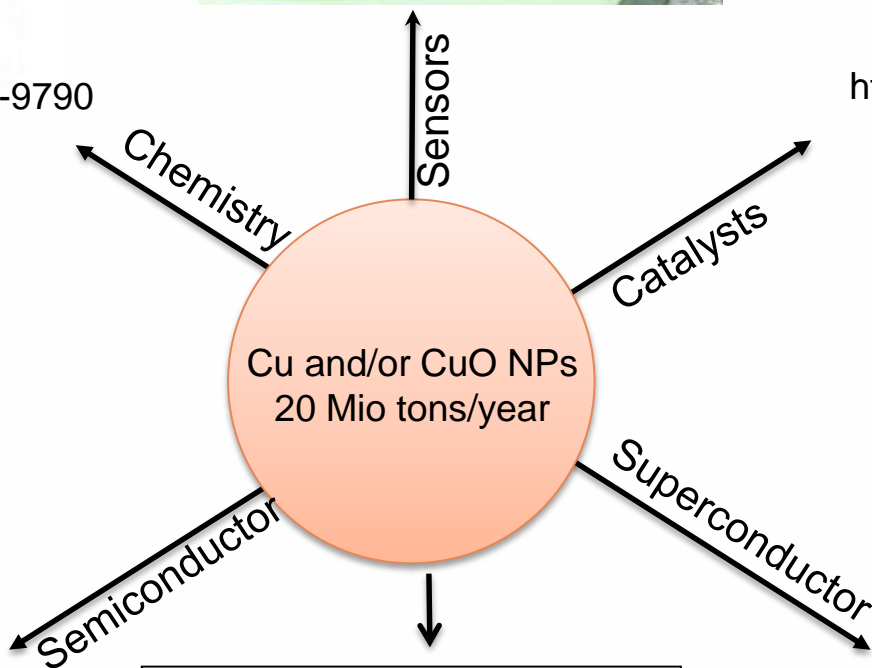
[spokhrel@iwt.uni-bremen.de](mailto:spokhrel@iwt.uni-bremen.de)



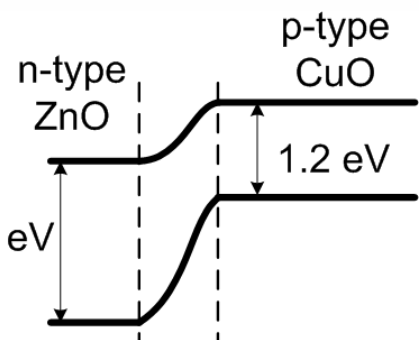
<http://bschemical.en.ecplaza.net/9.jpg>

*Nanoscale* 8 (2016) 9780-9790

Cu and/or CuO NPs  
20 Mio tons/year



DeMeo et al. 2011  
DOI: 10.5772/17644

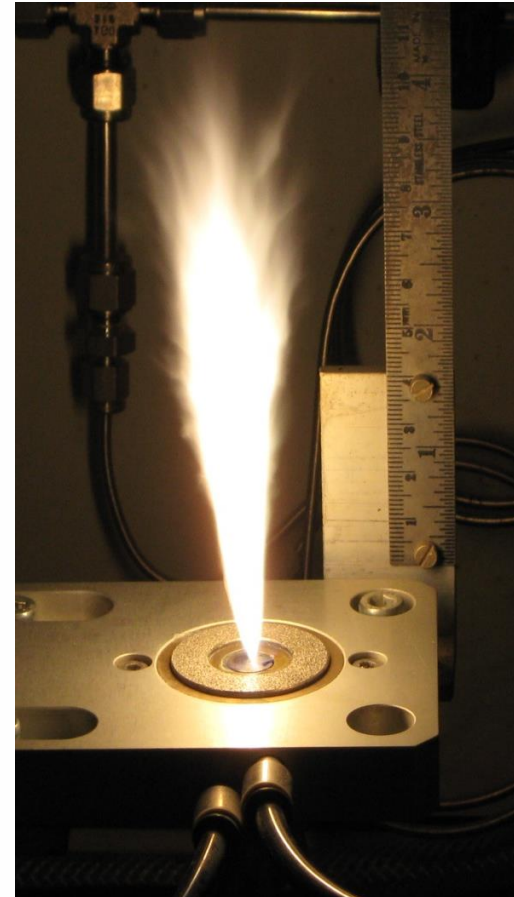
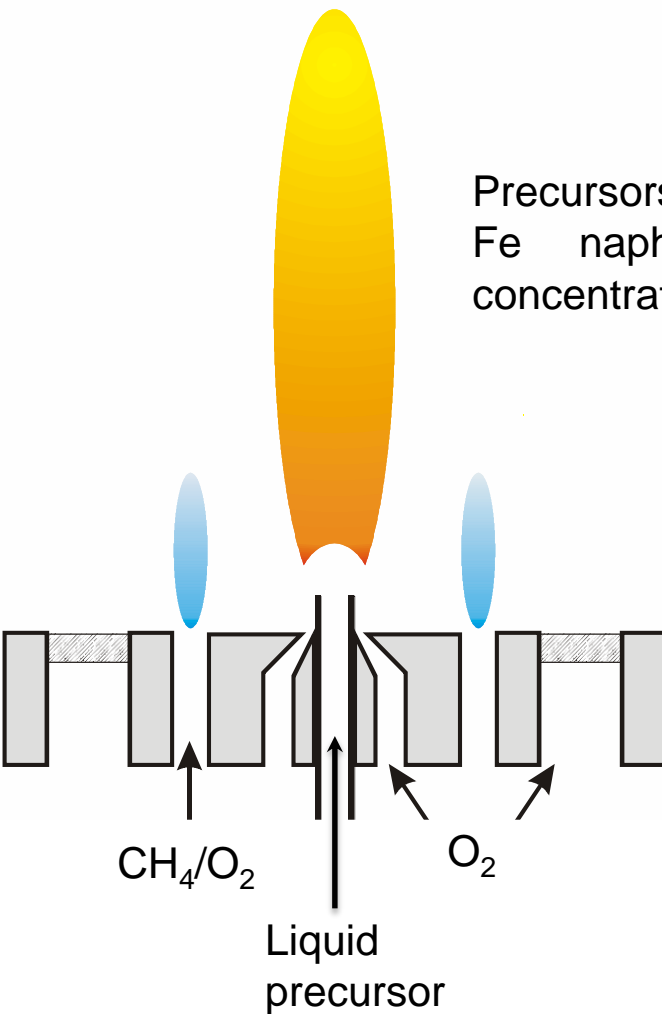


Cu<sup>2+</sup> is ultimately exposed to the humans and the environment

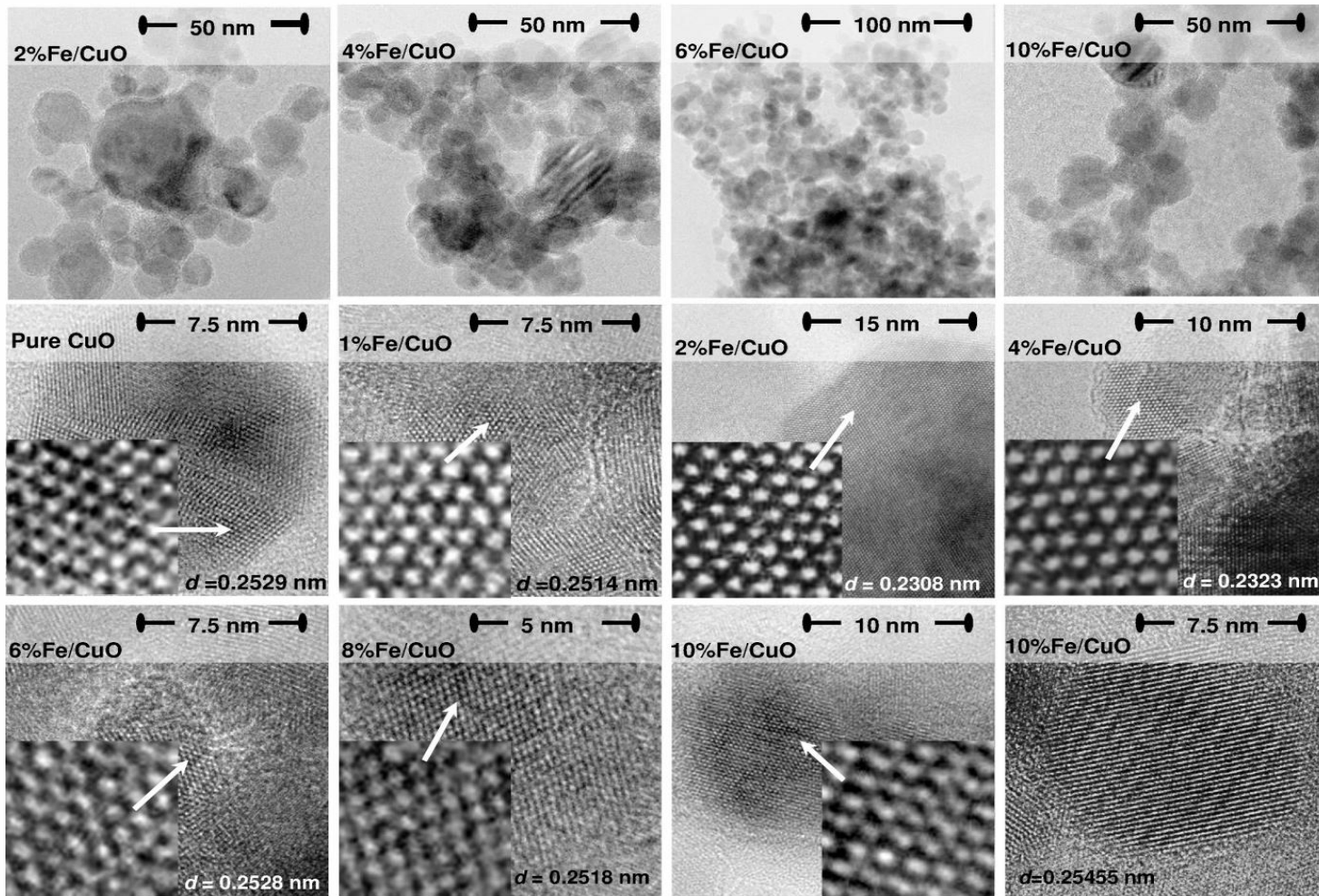
# Re-designing CuO: Flame Spray Pyrolysis

By Doping????

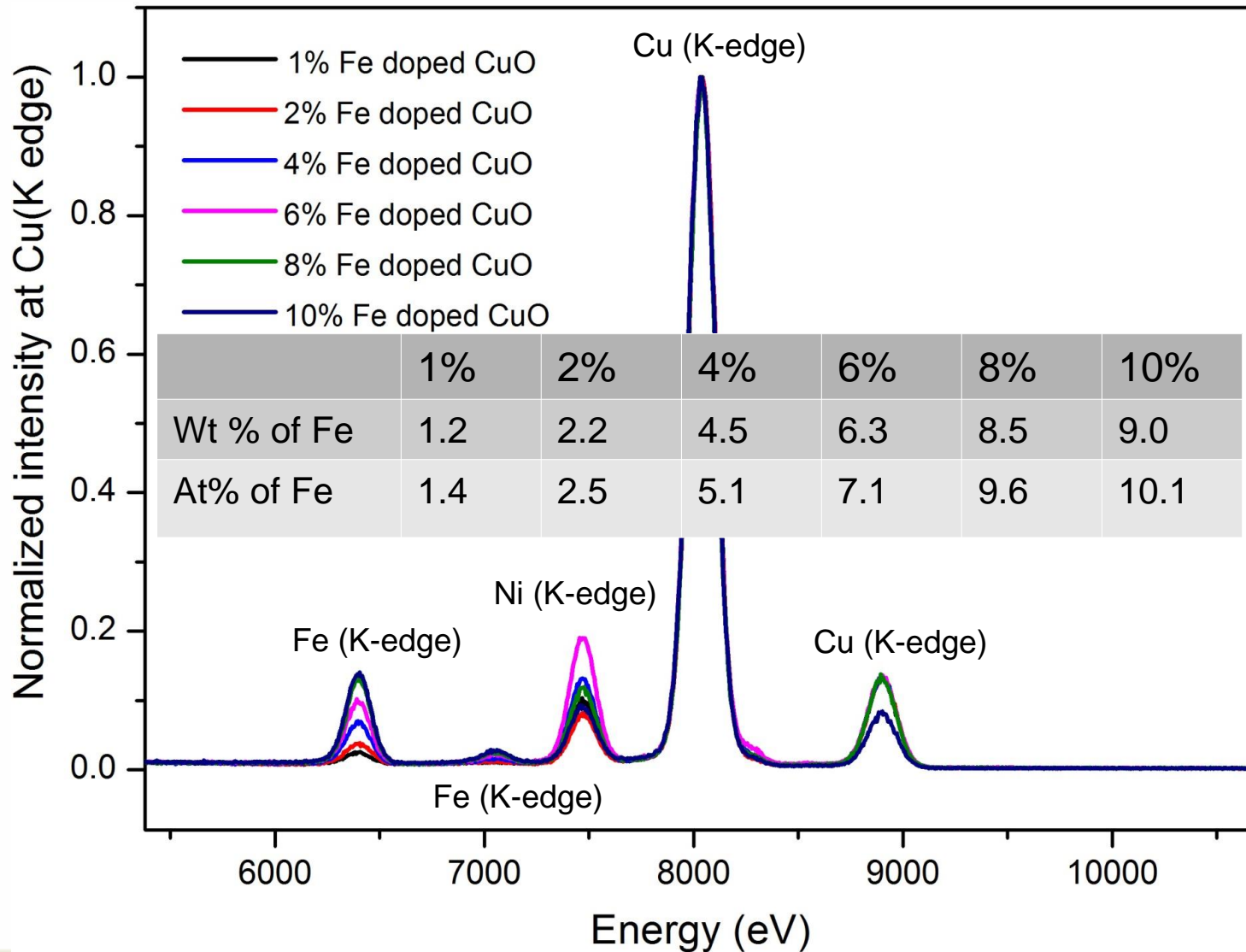
Precursors: Copper naphthenate +  
Fe naphthenate (0.5M Metal  
concentration) dissolved in xylene



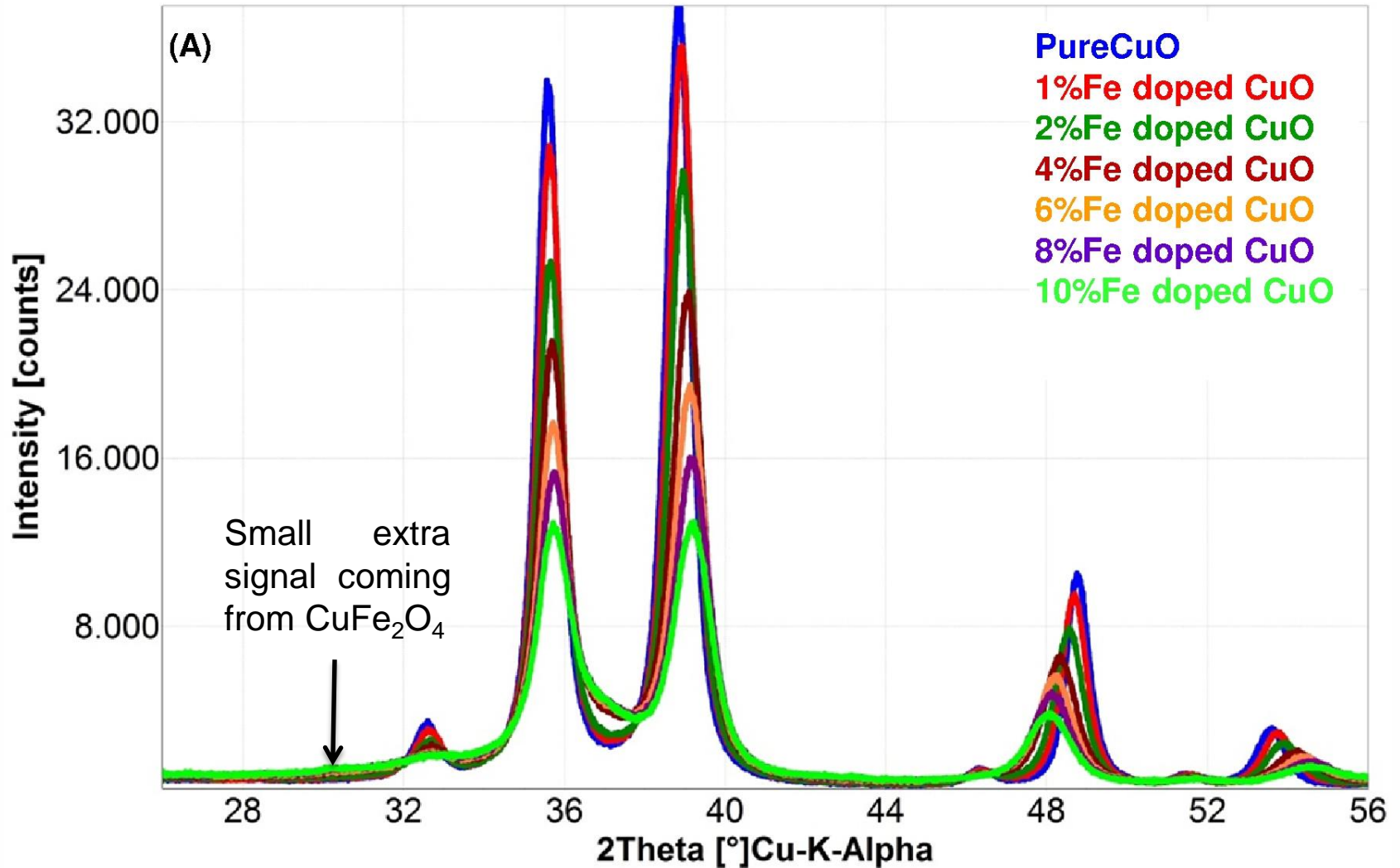
# Morphology and Crystallinity of NPs



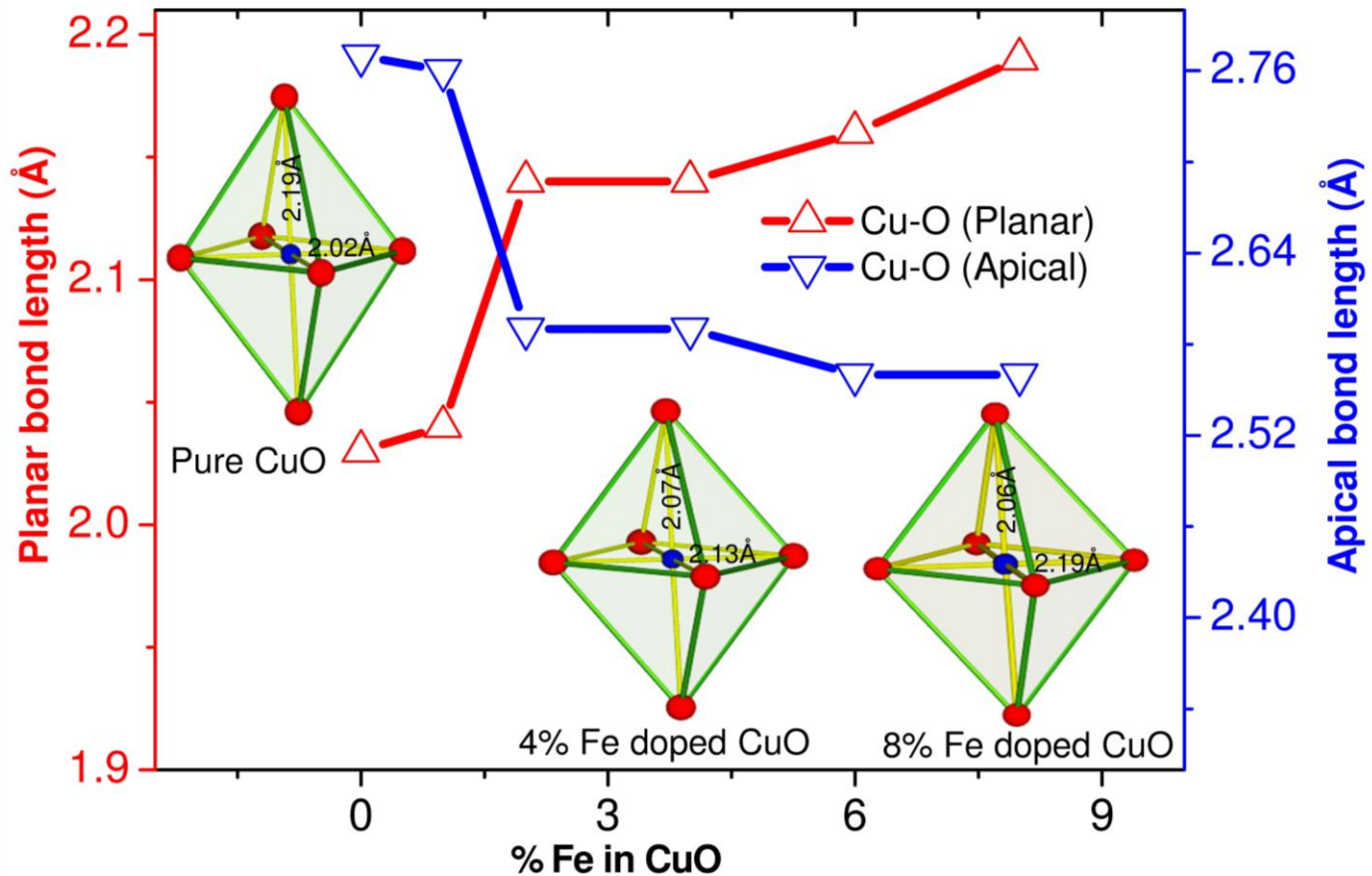
# Quantitative Analysis of the Dopant



# X-ray Diffraction: Structural Analysis of CuO Based NPs

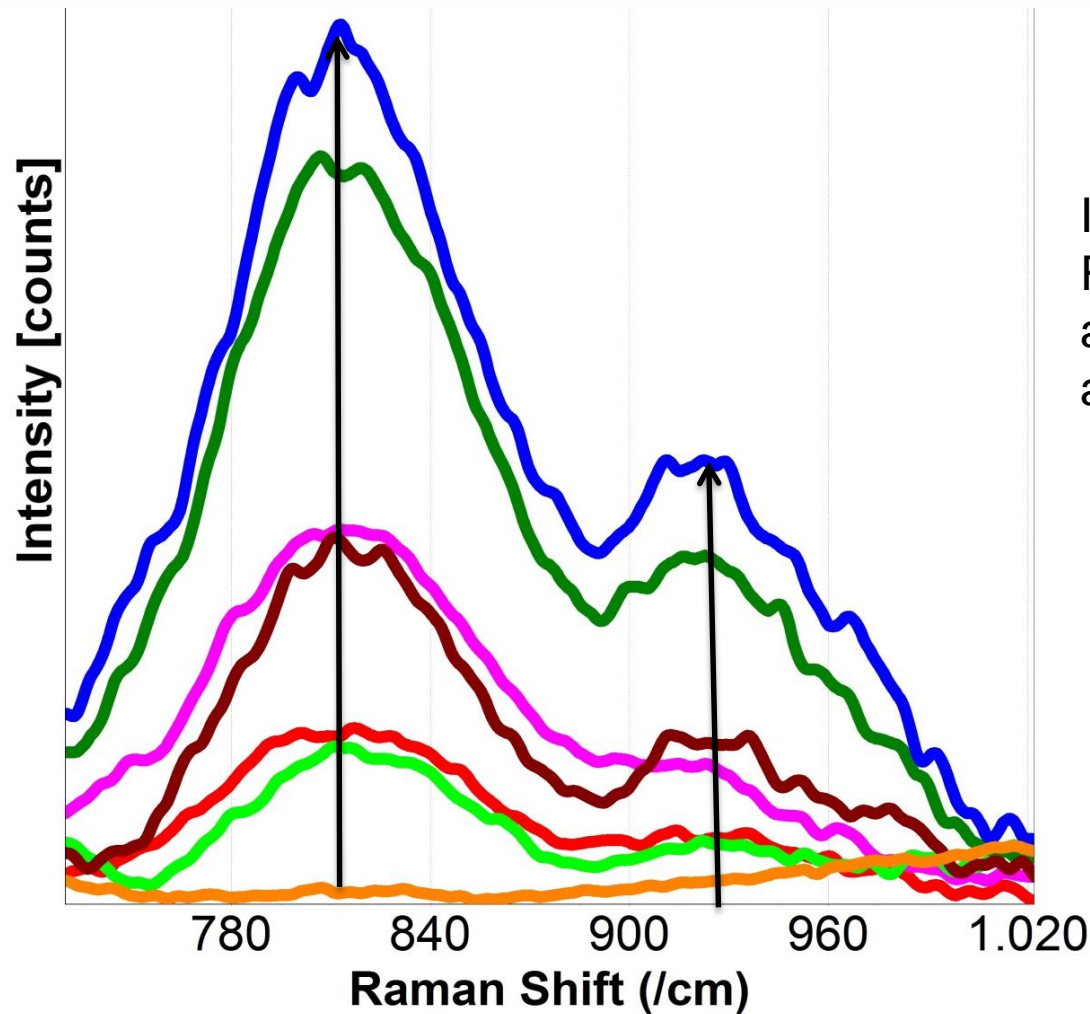


# Structural Analysis of the CuO Based NPs



Jan-teller distortion : 6.4% of plane elongation, 4.1% apparent distortion

# Raman Spectroscopy: Particle Analysis



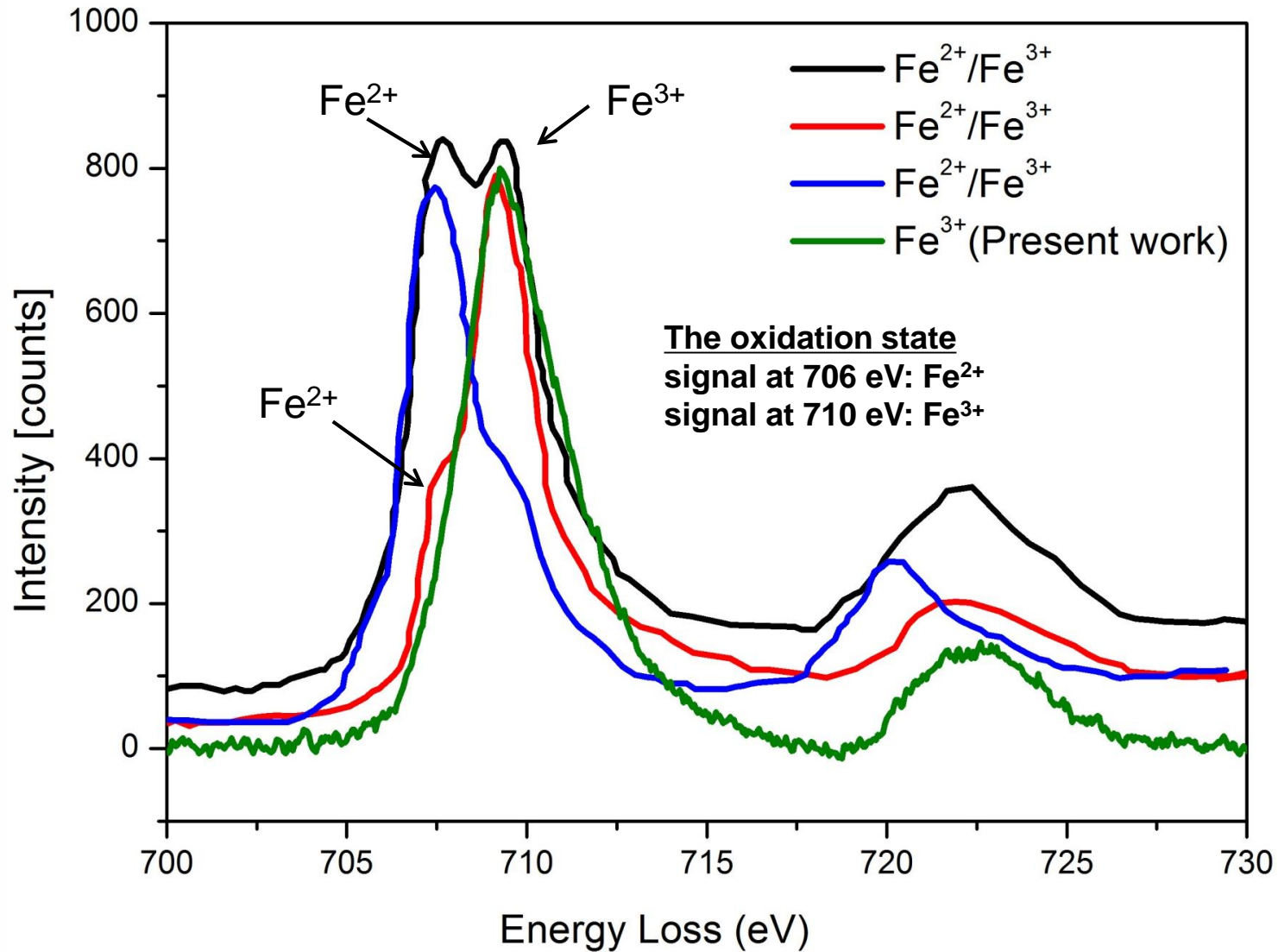
Increasing intensity of Raman signal centered at 813 and 926  $\text{cm}^{-1}$  is assigned to  $\nu$  (Cu-Fe-O)



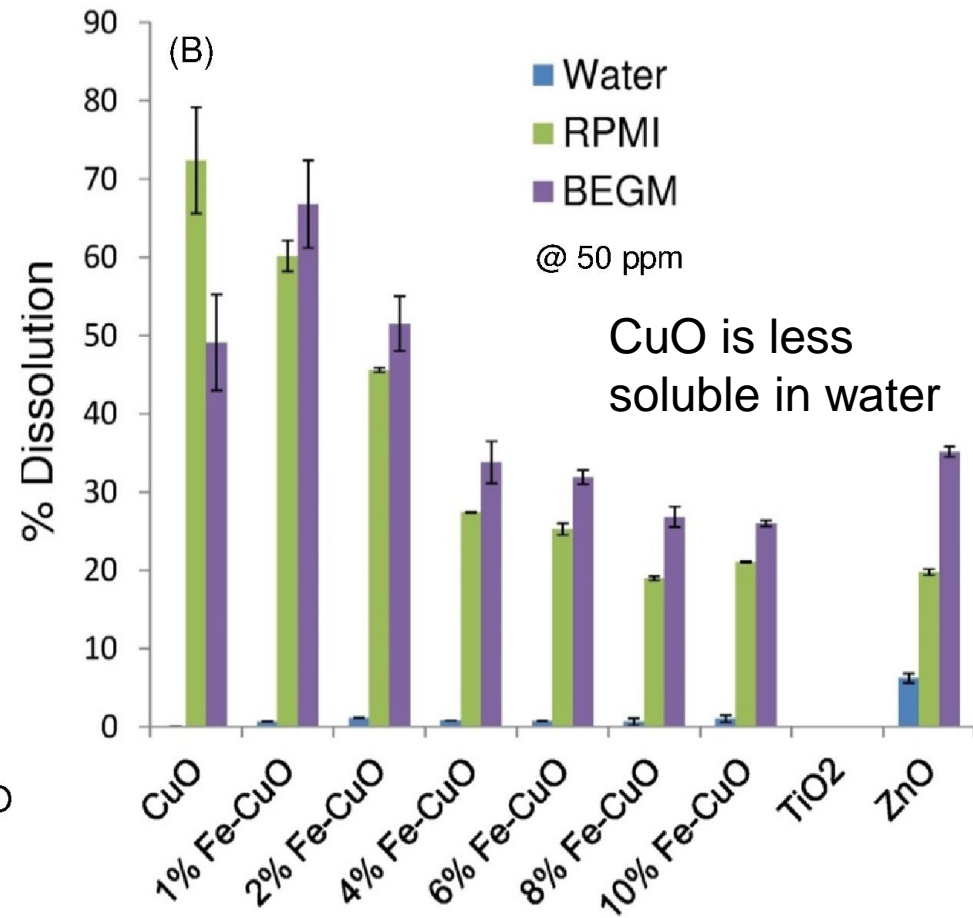
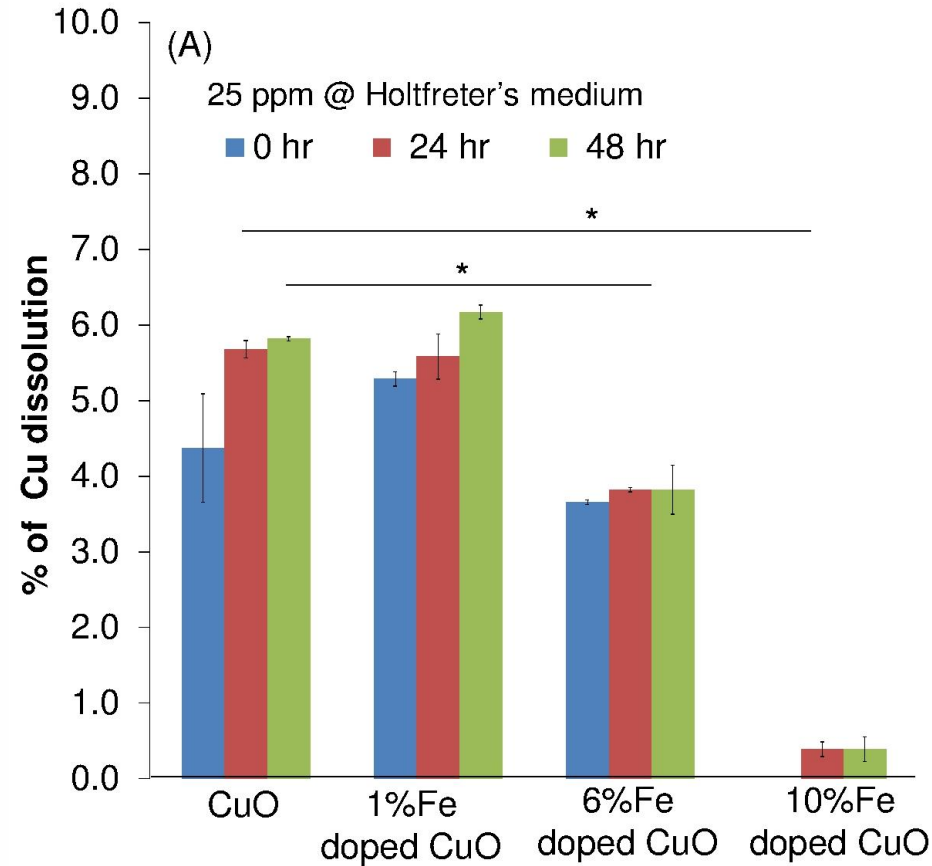
Successful doping



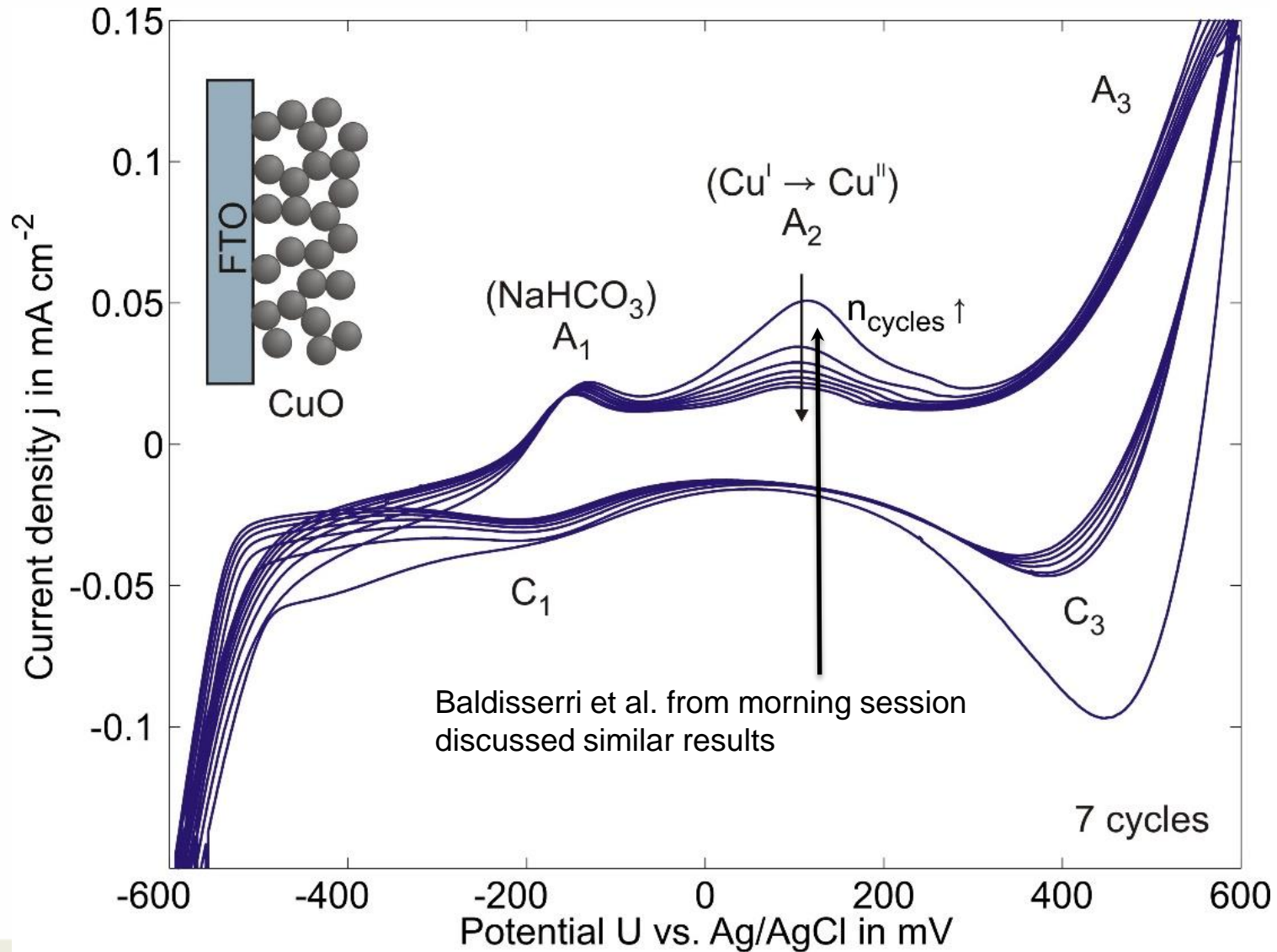
# Electron Energy Loss Spectroscopy: Oxidation State of Fe



# NP Dissolution in Water and Cellular Media

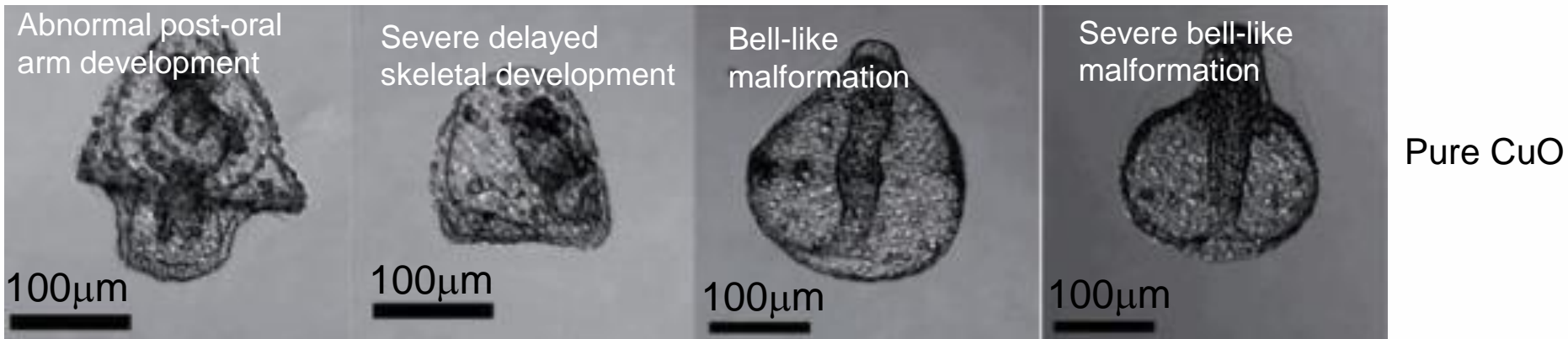
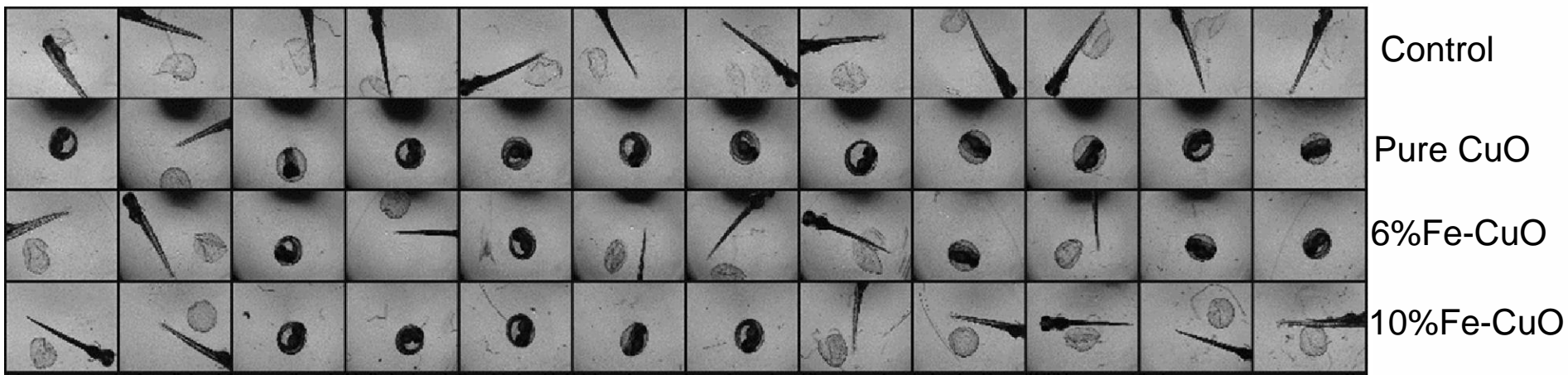


# Cyclic Voltammetry : Pure CuO

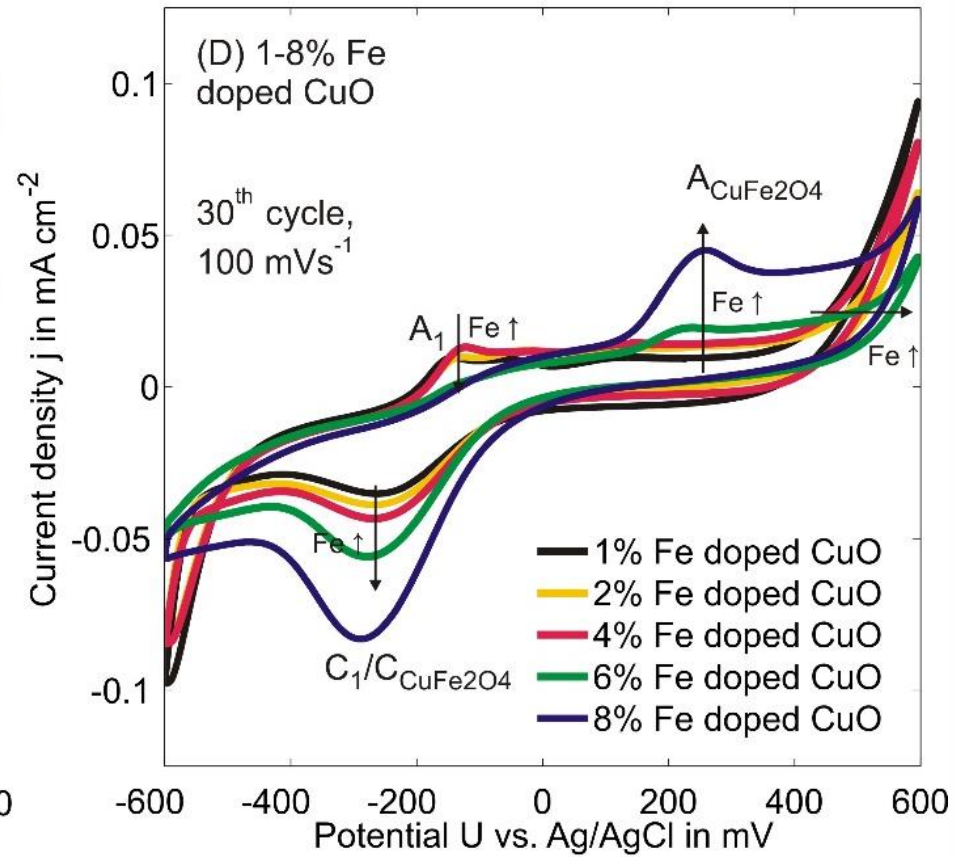
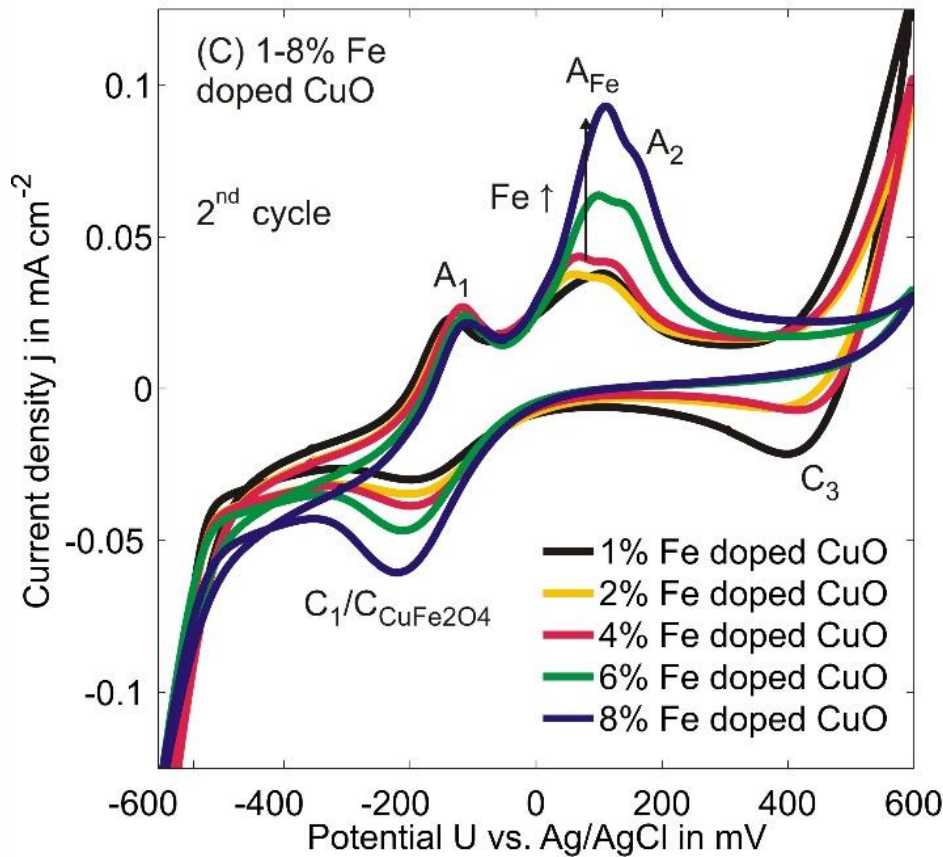


# Developmental Effects in Zebrafish and Sea Urchin Embryos

96h post exposure of CuO NPs



# Change in the Cyclic Voltammetry Signals With Cycling



# Safe-by-design: Toxic CuO Nanoparticles

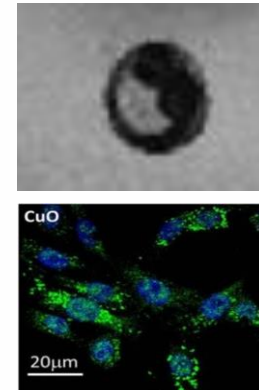
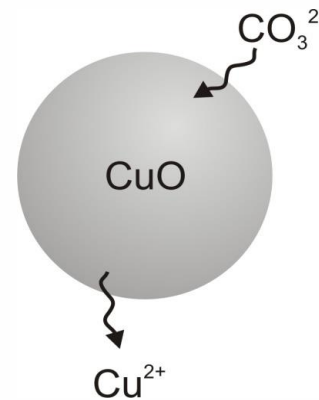
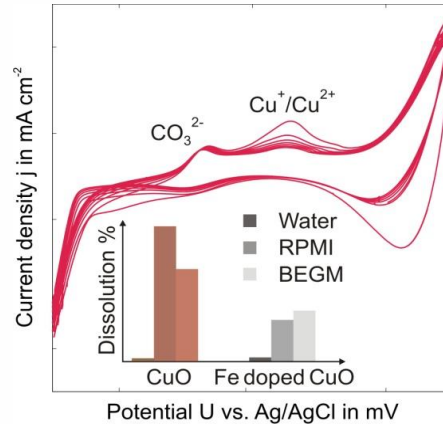
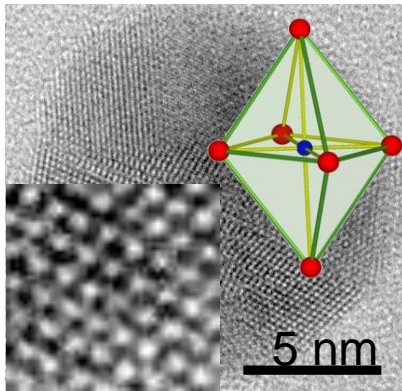
## Structural Properties

## Chemical Properties

## Surface Chemistry

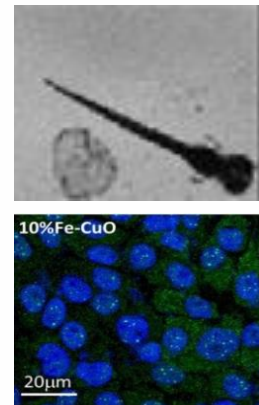
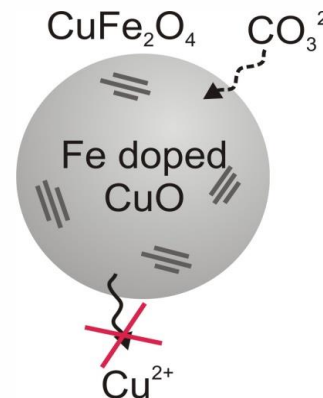
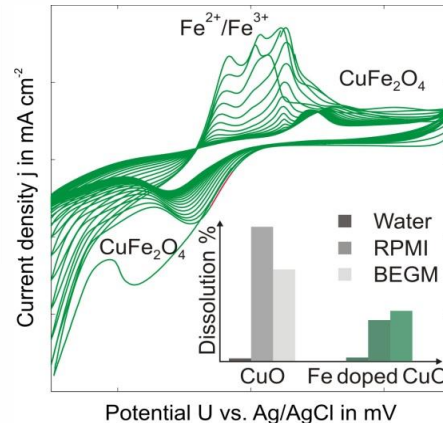
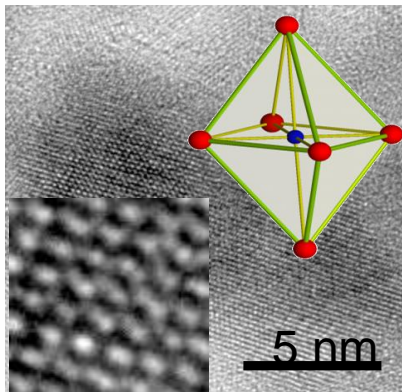
## Biological Response

CuO



## Safer-by-design

Fe doped CuO



# Acknowledgement

