Structural and gas sensing properties of greigite (Fe$_3$S$_4$) and pyrrhotite (Fe$_{1-x}$S) nanoparticles

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ABSTRACT:
Iron sulfide nanoparticles Fe$_3$S$_4$ and Fe$_{1-x}$S were synthesized via solvothermal decomposition of piperidine iron(III) dithiocarbamate complex in oleylamine. At a reaction temperature of 230 degrees C, the cubic Fe$_3$S$_4$ phase (greigite) was obtained whereas at 300 degrees C, monoclinic Fe$_{1-x}$S (pyrrhotite) was obtained. In both cases, hexagonal sheet like structures with sizes ranging from 50 to 200 nm were obtained. Powder X-ray diffraction studies reveal that the temperature plays a significant role in determining the crystalline structure and chemical composition of the as-synthesized nanoparticles (NPs). Gas sensing applications further reveal activities which are phase-dependent. The greigite has a higher response to humidity but saturates faster than the pyrrhotite. The pyrrhotite phase however outwits the greigite on response to H$_2$, NO$_2$, NH$_3$ and CH$_4$. In these gases, the greigite displays early saturation as well as noisy and uncoordinated signals.