Synthesis and Characterization of Novel Magnetic Core and Solder Shell Nanoparticles

Edward Fratto, Yang Shu, Fan Gao, and Zhiyong Gu

E-Mail: Edward_fratto@student.uml.edu

Department of Chemical Engineering
University of Massachusetts Lowell
One University Ave
Lowell, MA 01854

Abstract

We present the results of a novel core/shell magnetic nanoparticle synthesis mechanism and subsequent application to localized, on-site, on-demand soldering applications. The electronics industry faces increasing pressure to decrease device size but increase functionality; as components enter the micro- and even nano-scale, new methods of solder attachment are becoming increasingly vital. Magnetic iron oxide nanoparticles coated with solder material can be directed via magnetic field to targeted locations with greater precision than any current industrial technique. The shell of the proposed structure is composed of tin-indium solder which melts at temperatures below its eutectic point of 118 ºC; this is an important consequence of the nanomaterial's large surface area to volume ratio and unique surface properties. Given recent steps to phase out lead-tin solder (due to health concerns of lead), a gap has been created in the electronics industry where lead-free solders have been used but with less reliability and more uncertainty. These lead-free solders require not only higher processing temperatures (around 250-260 ºC) but also make the final devices more susceptible to external stress. We propose the new solder material to enable soldering at more reasonable processing temperatures using a green-chemical approach. The synthesis of the iron oxide core and subsequent solder deposition are run with water-based reduction chemistry without toxic organics. Similarly, the final product uses a halogen-free flux material and requires less overall energy to solder than the current lead-tin standard of the industry. Detailed herein are the essential synthesis steps and subsequent characterization of the material.

Keywords: core/shell nanoparticles, solder, magnetic, synthesis, self-assembly, green electronics