Highly Efficient Gold Extraction by Graphene

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Abstract

Gold is the most valuable element in e-waste. Currently, only less than 20% of e-waste has currently been recycled primarily for a lack of technologies with sufficient efficiency and economic viability to recover valuable elements within it[1-3], Therefore, developing materials capable of extracting gold from complex sources, especially electronic waste (e-waste), can turn the e-waste recycling challenge into a profitable business. Here we report an exceptionally high gold extraction capacity of chemically reduced graphene oxide (rGO), reaching >1.8 g/g when extracting gold from its 10 ppm solution at 25 °C (Fig.1), one order of magnitude higher than other reported gold adsorbents, and an ability to extract gold from ppt concentrations. During extraction, rGO reduces >95% gold ions to metallic gold, avoiding elution and precipitation necessary in post-adsorption processing (Fig. 1b). Moreover, this reductive adsorption of gold by rGO is found different from (predominately) electrostatic adsorption of other metal ions, hence, exploiting the protonation process of rGO, a precise gold extraction without adsorption of the other 14 elements normally present in e-waste is achieved. Finally, by assembling rGO nanosheets into a membrane, we have developed a rGO membrane-based continuous process that a 1 m^2 rGO membrane is capable of recycling gold from ~22,000 L of ~100 ppb gold solution. Our findings show a promising venue for addressing global e-waste challenges and gold scarcity.

References

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Figures

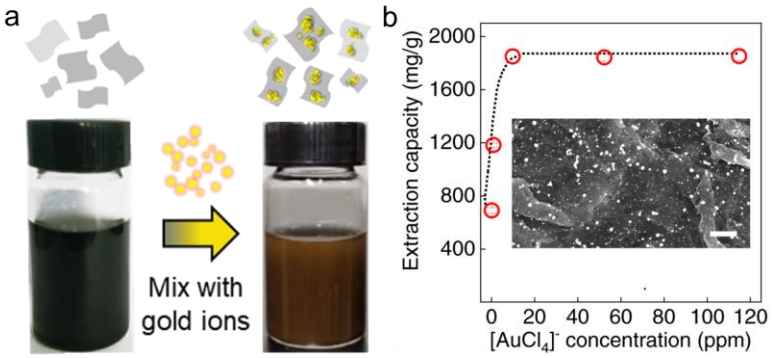

Figure 1: Gold extraction by rGO. (a) Schematic of the extraction process using rGO. After mixed with gold ion, rGO suspension gradually changed its color from black to brown. (b) Extraction capacity as a function of gold concentration after 24 h. Inset is a Scanning electron microscopy image of reduced gold nanoparticles adsorbed on rGO. Scale bar is 500 nm.