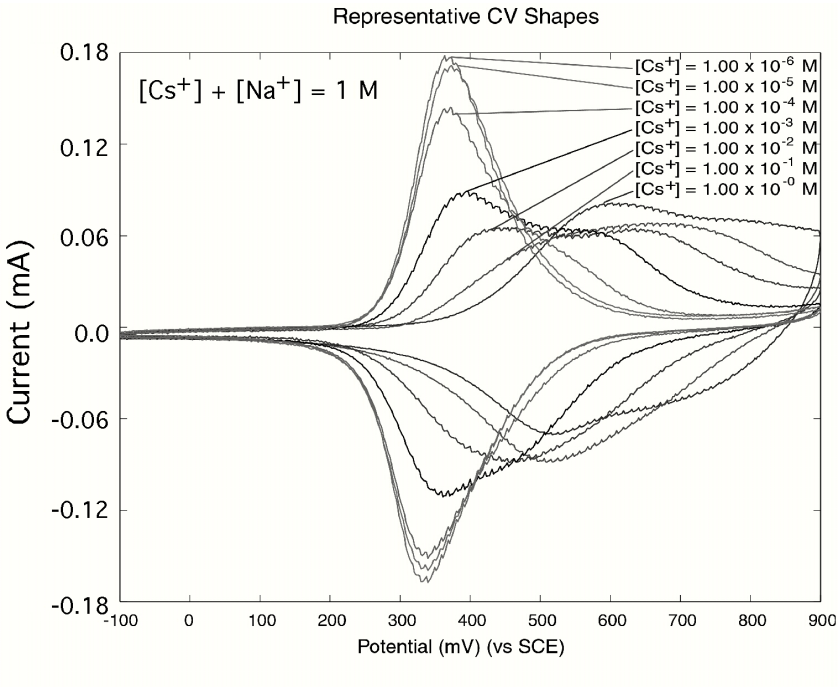
Cesium Sensing for Detecting "Dirty Bombs"

Radiocesium (^{137}Cs) is the main source of radioactivity in the U.S.—largely as a legacy of cold war nuclear weapons production—but it is also widely used in medicine, industry, and remote power production. Radiocesium has become the most cited[1] potential radiological source for so-called "dirty bombs" (conventional explosives used to disperse radioactivity). This concern is heightened by recent reports of lost radiocesium, including the disappearance of multiple radiothermal generators in the former-Soviet Union[2,3] (>40,000 Curies of ^{137}Cs) and the theft of an instrument with an 8 milliCurie ^{137}Cs source (later recovered in North Carolina).[4]



Nickel hexacyanoferrate (NiHCF) coated electrodes can be used to detect cesium, even in a large excess of other group I alkali cation interferants. The adjacent figure shows cyclic voltammograms for a NiHCF coated electrode immersed in seven different aqueous mixtures of Cs^+ and Na^+ nitrate (total cation concentration of 1 M). The shape and position of the voltammetric wave is seen to depend on the relative proportions of Cs^+ and Na^+ in solution.

SAFETY NOTE: All solutions used in this laboratory experiment contain the non-radioactive isotope of cesium (^{133}Cs), so don't worry!

In this lab, you are expected to deposit NiHCF according to the instructions given in reference [5]. Then, you should explore the sensitivity of the electrode to different ratios of Cs^+ to Na^+. Can you develop a univariate correlation for predicting Cs^+ concentration based on certain traits of the voltammogram? How does scan rate and the CV potential window affect your ability to measure and predict cesium concentration? Can you make an "unknown" mixture and determine the Cs^+ content? Would your studies using $^{133}Cs^+$ be equally valid for $^{137}Cs^+$?

1. Determined using a Lexis-Nexis search of the largest 50 U.S. Newspapers.
2. "Radioactive generators in ex-Soviet bloc pose terror risk," Agency France Presse (3/18/02).
3. "One kilogram of radioactive cesium confiscated in Lithuania," Interfax News Agency (5/18/02).
4. "Potentially dangerous radioactive gauge stolen," Associated Press (3/29/02).
5. K.M. Jeerage, W.A. Steen, and D.T. Schwartz, "Correlating nanostructure with ion intercalation in electrodeposited nickel hexacyanoferrate thin films," *Chem. Mat.* **14**, 530-535 (2002).