

Review of the Plasma treatment in Extraction of Thorium and Rare Earth Elements from Complex Ores

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ABSTRACT

Modern day technology such as electronics, magnets, and other high tech equipment all require Rare Earth Elements (REE) due to their unique properties. REE along with Naturally Occurring Radioactive Material (NORM) like thorium and uranium can be found in monazite. However, monazite is often cited as being too difficult, costly and dangerous to work with and is even a banned commodity in some countries. The problem is that conventional chemical digestion methods to recover these rare earth minerals are costly and highly toxic. In many cases this traditional recovery approach has caused significant environmental damage due to the radioactive waste produced and high quantities of caustic chemicals used, such as heated strong acids. Pre-treatment of monazite with high temperature plasma to chemically 'crack' the material has been shown to enable the extraction of the REE using relatively benign weak acids at room temperature. This approach has resulted in high recovery of both the 'light' and 'heavy' REE species. Experiments have shown that using a weak acid allows for the extraction of neodymium with low quantities of cerium and lanthanum, while capturing radioactive species such as thorium and uranium in a residue matrix as they do not leach in weak acids. The thorium and uranium can easily be stored, and if desired, processed separately using stronger acids. The overall ease of leaching plasma treated monazite thus significantly reduces the amount of undesirable caustic chemical and radioactive waste produced during the recovery process. Plasma pre-treatment of monazite therefore provides a mechanism to add high value to REE recovery by reducing recovery costs and environmental impact while also controlling the radioactive components for potential use in downstream nuclear applications.