THE ACTINOIDS

Actinoids (5f - Series)

The actinoids encompass the fourteen elements from Th to Lr. These elements are characterized by radioactivity, with the earlier members exhibiting relatively long half-lives, while the latter ones have half-life values ranging from a day to 3 minutes for lawrencium (Z = 103).

Electronic Configuration

The electronic configuration of all actinoids is generally believed to be $7s^2$ with variable occupancy of the 5f and 6d subshells. The fourteen electrons are formally added to 5f, with the exception of thorium (Z = 90). From protactinium (Pa) onward, the 5f orbitals are complete by element 103. Irregularities in the electronic configuration of actinoids, akin to those in lanthanoids, are linked to the stabilities of the f°, f^7, and f^{14} occupancies of the 5f orbitals. Consequently, the configurations of Am and Cm are [Rn] $5f^7\ 7s^2$ and [Rn] $5f^7 6d^1 7s^2$.

Ionic Sizes Atomic Size and Ionic Size

The atomic and ionic sizes of actinoids, which are elements belonging to the actinide series, are influenced by various factors including nuclear charge, electron configuration, and shielding effects. Generally, as one moves down the actinide series, both atomic and ionic sizes tend to increase due to the addition of new electron shells. This increase in size is primarily attributed to the additional electron shells being added, resulting in a greater distance between the outermost electrons and the nucleus.

However, within the actinide series, there can be variations in atomic and ionic sizes due to factors such as lanthanide contraction and relativistic effects. The lanthanide contraction refers to the relatively small increase in atomic size between successive elements of the actinide series compared to those of the lanthanide series. This phenomenon occurs because of poor shielding of nuclear charge by f-electrons, resulting in a contraction of atomic radii. Relativistic effects also play a role, especially in heavier elements, where the high speeds of electrons near the speed of light cause an increase in mass and contraction of atomic radii.

In terms of ionic size, actinoids typically form cations by losing electrons. The ionic size of actinoid cations tends to decrease across a period due to increasing nuclear charge, which attracts the remaining electrons more strongly, thus reducing the size of the ion. However, within a group, the ionic size of actinoid cations generally increases as the atomic number increases, corresponding to the increase in atomic size.

Overall, the atomic and ionic sizes of actinoids exhibit complex trends influenced by various factors, including nuclear charge, electron configuration, and relativistic effects.

Oxidation States

Actinoids exhibit a broader range of oxidation states, partly attributed to the comparable energies of the 5f, 6d, and 7s levels. In general, actinoids tend to show a +3-oxidation state. Elements in the first half of the series frequently display higher oxidation states. For instance, the maximum oxidation state increases from +4 in Th to +5, +6, and +7 in Pa, U, and Np, respectively, but decreases in succeeding elements. Similar to lanthanoids, actinoids have more compounds in the +3 state than in the +4 state. However, both +3 and +4 ions have a tendency to undergo hydrolysis.

General Characteristics and Uses

General Characteristics

Actinoid metals present a silvery-white appearance, yet their structures exhibit a wide range of diversity, owing to irregularities in metallic radii that exceed those seen in lanthanoids.

Actinoids, recognized for their pronounced reactivity, especially when finely divided, engage in reactions such as boiling water, leading to the formation of oxide and hydride compounds. These metals readily form compounds with the majority of metals under moderate temperatures. While hydrochloric acid reacts with all metals, nitric acid shows minimal effect due to the formation of protective oxide layers. Conversely, alkalies do not induce any reaction.

Uses of Actinoids

1. Thorium finds application in atomic reactors and cancer treatment. Additionally, its salts play a role in the production of incandescent gas mantles.
2. Uranium serves as a nuclear fuel and its salts contribute to various industries, including glass (for providing a green color), textiles, ceramics, and pharmaceuticals.
3. Plutonium serves a dual purpose, functioning as a fuel for atomic reactors and playing a crucial role in the production of atomic bombs.