



## The Chemistry of Alkali Metals: Properties, Reactions, and Applications.

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**Abstract:** This article provides an overview of the chemical properties of alkali metals, including their reactivity, solubility, and unique atomic structures. It could also discuss how these properties make alkali metals useful in a range of applications, from medicine to agriculture.

**Keywords:** Alkali metals, atomic structure, Electron configuration, Reactivity, Solubility, Alloys, Electrochemistry, Corrosion, Photovoltaics, Catalysis, Agriculture, Medicine, Energy storage, Semiconductors, Geochemistry.

**Introduction:** Alkali metals are a group of chemical elements that occupy the first column of the periodic table, including lithium (Li), sodium (Na), potassium (K), rubidium (Rb), cesium (Cs), and francium (Fr). The chemistry of alkali metals is characterized by their low ionization energies, high reactivity, and the tendency to form ionic compounds with nonmetals. These metals are soft, shiny, and have low melting and boiling points, which make them easy to work with. Alkali metals have a wide range of applications in different fields. Lithium is used in batteries, ceramics, and pharmaceuticals. Sodium is used in the production of soap, glass, and paper. Potassium is used in fertilizers, food additives, and detergents. Rubidium and cesium are used in atomic clocks, electronics, and research applications. Francium, on the other hand, is extremely rare and highly radioactive, so its applications are limited. The reactivity of alkali metals also makes them useful in the study of chemical reactions and the synthesis of new compounds. They are often used as reducing agents, catalysts, and in organic synthesis. Their unique properties also make them useful in the development of new materials, such as superconductors and semiconductors.

### Properties of Alkali Metals

Alkali metals are characterized by their low melting and boiling points, low densities, high reactivity, and the ability to form ionic compounds with non-metals. The melting and boiling points of alkali metals decrease as you move down the group, with francium having the lowest melting and boiling points of any element. This trend can be explained by the increasing size of the atoms and the decreasing strength of the metallic bonds.

Alkali metals are also known for their softness and malleability, which makes them easy to shape and mold. This property arises from the metallic bonding in the crystal lattice structure of the metals, which allows for the movement of electrons and the ability to deform without breaking.



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Another important property of alkali metals is their high reactivity. These metals readily react with water and oxygen in the air, producing hydrogen gas and metal hydroxides or oxides. The reaction with water becomes more violent as you move down the group, with francium being the most reactive of all the alkali metals.

## Reactions of Alkali Metals

The high reactivity of alkali metals is due to the low ionization energies of their outermost electrons. These electrons are easily removed, allowing the metals to form positive ions and react with other substances.

One of the most common reactions of alkali metals is with water. When an alkali metal is added to water, it rapidly reacts to produce hydrogen gas and metal hydroxides. The reaction becomes more vigorous as you move down the group, with francium reacting explosively with water.

Alkali metals also react with halogens, such as chlorine and fluorine, to form ionic compounds known as metal halides. These reactions are highly exothermic and can produce intense light and heat.

## Applications of Alkali Metals

Alkali metals play a vital role in many different fields, including energy, medicine, and electronics. One of the most significant applications of alkali metals is in batteries, where lithium and sodium are commonly used as anodes. These metals have high energy densities and can store large amounts of electricity, making them ideal for use in portable electronic devices and electric vehicles. Alkali metals are also used in the production of fertilizers and other agricultural chemicals. Potassium, in particular, is an essential nutrient for plant growth and is commonly added to soil to improve crop yields. In the field of medicine, alkali metals are used for a variety of purposes, including the treatment of bipolar disorder and as a tracer in medical imaging. Lithium, in particular, is commonly used as a mood stabilizer in the treatment of bipolar disorder. In the electronics industry, alkali metals are used to produce semiconductors and as a component in photovoltaic cells. For example, cesium is used in atomic clocks, which are essential for precise timekeeping in many different applications.

## Challenges and Risks Associated with Alkali Metals

While alkali metals have many valuable properties and applications, they also present several challenges and risks. One of the most significant challenges is the high reactivity of these metals, which can make them difficult to handle and store safely. Alkali metals are also highly corrosive and can react with many different materials, including water, acids, and organic compounds. This property can make it challenging to design and maintain equipment that comes into contact with alkali metals. Another challenge associated with alkali metals is their low abundance in the earth's crust. While some of these metals, such as sodium and potassium, are relatively abundant, others, such as lithium and cesium, are much rarer. Additionally, some alkali metals, such as lithium, have been associated with environmental and health risks. Lithium mining and processing can lead to soil and water contamination, and excessive lithium intake can cause kidney and thyroid damage. One example of the importance of alkali metals is in the development of rechargeable batteries. Lithium-ion batteries, which use lithium as the active material in the electrode, have become



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ubiquitous in modern society, powering everything from smartphones to electric cars. The high reactivity and low weight of lithium make it an ideal material for use in batteries, and ongoing research is exploring the potential of other alkali metals like sodium and potassium for use in similar applications.

Another example of the versatility of alkali metals is in the field of organic chemistry. The strong reducing power of these elements makes them useful in the synthesis of a wide variety of organic compounds. For instance, sodium borohydride ( $\text{NaBH}_4$ ) is a commonly used reducing agent in organic chemistry, reacting with aldehydes and ketones to form alcohols. The reducing ability of alkali metals can also be used in the production of fine chemicals, such as pharmaceuticals and agrochemicals.

## Conclusion

In conclusion, alkali metals are a fascinating group of elements with unique properties and a wide range of applications in science and technology. Their high reactivity and distinctive physical properties make them valuable for a variety of uses, including energy storage, agriculture, medicine, and electronics. However, the challenges and risks associated with these metals must also be considered, and efforts must be made to ensure that they are handled and used safely and responsibly. As research continues, it is likely that new applications for alkali metals will be discovered, making them an exciting area of study for scientists and researchers alike.

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