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Michael Freemantle, *Gas! Gas! Quick, Boys! How Chemistry Changed the First World War*. Stroud, UK: Spellmount, 2012. Pp. 240. ISBN 978–0–7509–5375–7.

Review by Alan Hawk, National Museum of Health and Medicine (alan.j.hawk.civ@mail.mil).

This book offers much more than a conventional history of chemical warfare. Its author, chemist and science writer Michael Freemantle, explores in an engaging and conversational manner the profound effects of chemistry on the nature of combat in World War I, describing in detail the origin, manufacture, and military applications of, for example, mustard gas, galvanized steel, dyes, and antiseptics. He establishes the thesis of his book by quoting chemist and inventor Leo Baekeland, speaking in 1915: "Modern war, whether it be for robbing, plundering and subjugating other nations, or for legitimate self-defense, has become primarily dependent upon exact knowledge, good scientific engineering and, to a large extent, applied chemistry" (11).

At first look, the book's genre seems familiar—a technological history of the First World War, featuring detailed accounts of the devastating impact of machine guns, airplanes, submarines, and armored tanks. But Freemantle departs from such a traditional perspective by his special emphasis on the novel raw materials—metals, textiles, chemical compounds, etc.—that went into the devising and mass manufacturing of the pharmaceuticals, protective equipment, and weaponry that distinguished the Great War from those that had gone before.

For example, the high explosive shells that so defined the war were the end result of a series of chemical processes involved in the construction of metal shells that would shatter on explosion and the fuses that would initiate the detonation of a precise combination of substances in order to fracture the shell. Most military historians assess the scale and effects of the artillery barrages that, along with machine gun fire, so effectively checked offensive operations and led to a four-year stalemate. Freemantle, by contrast, meticulously describes just what went into the development and creation of the artillery shells and fuses themselves.

> Fabrication of a fuse for a World War I shell typically required 50 or more components, including, depending on the type of fuse, not just the firing pins and time rings but also plugs, springs, spindles, bolts, collars and hammers. Some of these parts, particularly items like washers, were made from materials such as paper, cloth or leather. However, the vast majority of fuse components were manufactured with precision engineering from brass, steel, phosphor bronze and other alloys as well as from metallic elements such as aluminum, tin, copper and lead.
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> To work, they also needed detonating and boosting explosives. Mercury fulminate, a chemical compound that contains carbon, nitrogen and oxygen, as well as mercury, was widely used as a detonating explosive, either by itself or in mixture with other materials. Other detonating compositions used in the war contained potassium chlorate, a compound of potassium, chlorine and oxygen. Some types of fuses employed "mealed powder," a dust-like form of gunpowder that readily explodes when struck by a firing pin, to fire the booster explosive in the fuse magazine. (35)

To give some sense of the scale of munitions requirements, he notes that British and German forces fired thirty million shells, nearly 150 per minute, at each other during the Battle of the Somme (1 July–18 November 1916).

The book is more an encyclopedia than a traditional narrative history, covering everything from the metals that lined trenches or went into helmets to the fabric used on aircraft and the specific explosives contained in bombs, bullets, artillery shells, and hand grenades. The effect is of an exhaustive overview of the technological and scientific advances of the early twentieth century that unleashed the horrifically destructive forces of the First World War.

Chapter 1, “The Chemists’ War,” sets the theme of the book and surveys the revolutionary developments of nineteenth-century chemistry. These included the creation of synthetic dyes, which led to the industrial production of other chemicals, the development of the first plastics, and the use of electrochemistry to produce metal alloys and new chemical compounds. Chapters 2, “Shell Chemistry,” 3, “Mills Bombs and Other Grenades,” and 4, “The High and Lows of Explosives,” describe bomb production and the manufacture and characteristics of various explosives. Chapter 5, “The Metals of War,” explains the role of metal alloys in everything from shell casings to the aluminum frames of zeppelins and the galvanized steel used to reinforce trench networks. Chapter 6, “Gas! GAS! Quick, Boys!” concerns weaponized chemical agents and the gear designed to protect against them. Chapter 7, “Dye or Die,” deals with synthetic dyes used to color uniforms. Chapter 8, “Caring for the Wounded,” details the organization of medical facilities for the sick and injured, providing context for chapters 9, “Fighting Infection,” and 10, “Killing the Pain,” which review the medical applications of chemistry from pharmaceuticals to disinfectants, anesthetics, and vaccines. I would have liked more detail on the development and manufacturing of pharmaceuticals. The final chapter, “A Double-Edged Sword,” provides concluding remarks.

The book’s only significant weakness is its failure to put a human face on the chemistry of the war. For example, there is remarkably little on the character and personality of Fritz Haber, a key figure in the scientific aspect of the war who weaponized chlorine gas for the first chemical attack. Freemantle’s cursory account of the identifying and adaptation of chlorvinyldichlorarsine, later called Lewisite, for military purposes by Catholic University chemist Winford Lewis has none of the drama of, for example, Richard Rhodes’s narratives[1] of the men and women who developed the atomic bomb during the Second World War. Nor is there much here on the workers who processed the materials or the factories where they worked.

This surprisingly compelling book provides valuable context by discussing what was required to support the massive armies and combat operations of World War I. Chemistry involves precision work, the ability to make careful distinctions based on a deep understanding of the properties and interactions of elements and compounds.[2] The modern age would not exist without its often unseen presence, for good or ill. I hope that the author or other scholars will adopt the approach used here in studying the effects of scientific advances in, for instance, the US Civil War, World War II, or the Global War on Terrorism. Michael Freemantle’s astute and informative explanation of “How Chemistry Changed the First World War” belongs on the bookshelf of every serious student of military history and in the footnotes of subsequent histories of the Great War.

1. In *The Making of the Atomic Bomb* (NY: Simon & Schuster, 1986).

2. On display in Freemantle’s previous book, *An Introduction to Ionic Liquids*, published by the Royal Society of Chemistry (Cambridge, 2009).