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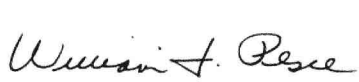

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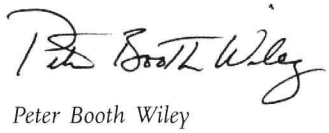

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Foreword

Whoever is ignorant
of the four elements,
of the strength they wield
and of their quality,
cannot master
the band of the spirits.

Johann Wolfgang von Goethe, *Faust I, Study*

In *Faust*, Johann Wolfgang von Goethe shows, in masterly fashion, the magic attraction of the elements or alchemy (chemistry), whilst at the same time claiming that another field – the one of the spirits or, in a more open interpretation, the one of philosophy and arts – is of fundamental importance. In the present collection of spectacular chemical experiments, Herbert W. Roesky has created a fascinating amalgam of brilliant chemical experiments, in addition to a variety of amusing and pensive aphorisms, quotations, anecdotes, and small stories originating from this universe that is almost lost to the scientist or, more generally speaking, to *homo technicus* or at least far away from him. In his book *Chemical Curiosities*, the author has already proved convincingly, that this synthesis of natural science and arts is not a combination of fire and water but rather two sides of the same medal. It is very good that again a bridge has been thrown across two disciplines of the modern world which seem to be far away from each other.

This book contains new "bang and smoke" experiments that make people's hearts beat faster (see Münchhausen's canon ball, bromide and potassium!!). It can also revive playful instincts ("sodium billiards") or raise magic reactions ("the alchemist's gold"). It is possible that some people might prefer the aesthetics of some experiments or the fascination of art (beautiful color experiments). In this book, the varied journey through an easily understandable pure scientific

Spectacular Chemical Experiments. Herbert W. Roesky

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universe with anecdotes, quotations, and brief stories introducing every experiment not only becomes an adventure but also perhaps gives us back some of the magic that is inherent in the worlds of both chemistry and arts.

George A. Olah

Preface

After having delivered more than 150 "experimental" lectures outside Göttingen, and in eight different countries, I decided to write a third book containing spectacular experiments. These experiments are introduced by poems, anecdotes, epigrams, and interesting stories, which elucidate the ubiquitous character of chemistry and arts.

I realized that the existence of the two cultures, as stated by C.P. Snow in 1959 for science and arts, is perceived only after puberty. This is due to the different kinds of education and different schools of thought which are presented to school children. As early as 1947, the mathematician Wiener referred to this difference in his book, *The Intellectual and the Scientist*:

"We have seen, that communication is the mortar of society and that those, who charge themselves to maintain undisturbed the means of communication are mostly responsible for the continuation or the decay of our culture. Unfortunately, these priests of communication are separating in two orders or sects, which defend different principles and have a different education. These two orders of communication priests are, on the one hand, the intellectuals and the arts scholars, on the other hand, the scientists. [. . .] I do not criticise the hostility of the intellectuals and arts scholars towards science and machine age. Hostility is positive and creative, and much of the progression of the machine age demands active and deliberate resistance. I rather criticise him because of his lack of interest in the machine age. He thinks that it is not important to know thoroughly the principles of science and technology, and to become active where these principles are concerned. He is hostile but his hostility does not urge him to do something. It is some kind of homesickness of the past, a vague uneasiness with regard to the present more than any deliberate attitude."

Moreover, I think it is important that chemistry is presented in a charming and inspiring way, and not only with "bang and smoke" experiments. "Chemistry has to be good", people say, and this means positive rather than deterring experiences in the lecture hall. Communication and inspiration between science and arts is also very important.

Spectacular Chemical Experiments. Herbert W. Roesky

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The experiments in this book are not presented in any systematic order. Apart from the classical experimental art, two new types of presentation are introduced. On the one hand, these are reactions in the gas phase, for example the precipitation of silver chloride and the identification of alcohol. On the other hand, we use a digital camera in order to record the reaction in pictures; this process can be found in Part VII, the "Art Gallery of Chemistry". Using this method, the person performing these experiments can demonstrate his or her work convincingly, even outside the laboratory, such that science and art – two demanding and creative activities – can be shown together.

During the writing of this book I have greatly appreciated the books of B.Z. Sakhashiri, *Chemical Demonstration – A Handbook for Teachers of Chemistry*, the *Journal of Chemical Education*, and *Chemie in unserer Zeit*. I am also very grateful to Henry Fraatz, who not only supervised and optimized all the experiments but without whom this book would not have been written.

Finally, I would like to quote the advice of Franz Kafka for all those who have decided to perform experiments to fill the audience with enthusiasm:

"Do not spend your time by searching obstacles, maybe there are none."

Herbert W. Roesky

Contents

Spectacular Chemical Experiments. Herbert W. Roesky

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Part I
Water

I don't know who discovered water, but it probably wasn't a fish.

Herbert Marshall McLuhan

From heaven it comes,
To heaven it goes,
And down again
To the earth
Endlessly changing.

Ferdinand Fischer

Water is one of Aristotle's four elements. Thales described it as the only true element from which all the other materials originate. Today, we know that without water, life and evolution are impossible.

This is true even at the beginning of the 21st century. Europe and the United States are competing to discover if there is human habitation on Mars (Beagle 2 and Spirit). In the solar system, Mars is much more like Earth, and scientists consider that, some 3.5 billion years ago, today's icy planet was warm and humid. Although there is always water on Mars, it exists as a more or less thick layer of ice.

Water is vital both inside and outside the human body.

The water percentage in the human body:

Age	Water content (%)
Day of birth	79
5 years	2
16 years	58
Adult	
Normal weight	62
Very slim	69
Very fat	42

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The water percentage inside the different organs:

Organ	Water content (%)
Eyeball	99
Brain	84
Heart	74
Liver	72
Bones	55
Hair	4
Teeth	0.2

Inside the human body, water transports dissolved materials to the different organs and the cells, and it also serves to maintain the functions of the cells. Water is also necessary for the digestion of food and the transportation of its components.

Water is not always drinking water; the oceans, for example, contain 4% of salt which is mostly sodium chloride. Shipwrecked persons who drink water with such a high salt content can survive for only a short period of time.

Water is a very good solvent. In fact, drinking water contains almost every soluble material with which it comes into contact. However, only 0.27% of all of the water on Earth can be used as drinking water.

Experiment 1
Spontaneous Ignition by Adding Water

Whoever is ignorant
of the elements,
of the strength they wield
and of their quality
Cannot master
The band of the spirits.

Johann Wolfgang von Goethe

Apparatus

A fire-proof support, one 250-mL beaker, one wash-bottle, safety glasses, protective gloves.

Chemicals

Wood shavings, Na_2O_2, water (or champagne, beer, etc.).

Attention!

Na_2O_2 reacts almost like sodium spontaneously with water. Na_2O_2 and hydrogen peroxide can cause burns, and skin contact must be avoided. Do not scale up the amount of Na_2O_2. Safety glasses and protective gloves must be used at all times.

Experimental Procedure

The wood shavings are loosely filled into the beaker and the latter is placed on the fire-resistant support. Before starting the experiment, 0.4 g of Na_2O_2 is placed on the wood shavings and immediately a few drops of water are added. The water reacts spontaneously with the Na_2O_2, and the wood shavings start to burn. In most of cases, the beaker cracks.

Explanation

Na_2O_2 is a strong oxidizer and reacts very often explosively with unsaturated organic compounds under incandescence. In the presence of small amounts of water, Na_2O_2 reacts under the elimination of oxygen:

$$Na_2O_2 + H_2O \rightarrow 2\ NaOH + O$$

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