

Chapter 17

Quantum Computing in the Era of Intelligent Battery Design

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ABSTRACT

Quantum computers can fix problems that regular computers can't. Quantum computing is used to quickly find new materials with useful properties, correctly simulate electrochemical processes at the atomic level, and make batteries work better and last longer by tweaking their structures. The authors also look into how quantum models can help us understand the complexities of charge transport, interface phenomena, and degradation pathways in batteries better. Combining quantum computing with research methods like quantum sensing and quantum annealing might make it easier to test theoretical theories and get around problems that come up in real life. Scientists can learn more about how batteries work by using quantum computing. This will lead to the creation of advanced battery management systems and personalized energy storage solutions. This work shows how quantum computing is changing the way batteries are designed, optimized, and understood. As a result, it starts a major shift in energy storage systems that makes them much more efficient and better for the environment.

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INTRODUCTION

McClellan 2017 Recently, there has been a lot of talk about how quantum computing and smart battery design could change many businesses in new ways. This includes many different kinds of goods and tools, like electronics for everyday use and clean energy. The power of quantum computing to solve difficult optimization problems is changing how we think about, model, and make batteries.

Wecker D 2013 This is because traditional computer methods have always made it hard to design batteries because they can't properly show the complex quantum events that are essential to battery performance. In spite of these problems, the development of quantum computing has given experts new ways to get around them. They might be able to learn more about the basic physics of batteries and come up with new designs and materials that are more precise and effective than anything else ever seen.

R. Babbush 2018 Quantum computers, which can model how things behave at the subatomic and atomic levels, helped researchers understand how chemical processes, electron transport, and structure dynamics research together in battery systems. Quantum physics has opened up new ways to make batteries work better, last longer, and be more reliable. This could lead to the creation of more advanced energy storage systems in the future.

Christo Ananth 2022 Additionally, quantum computing offers important tools for quickly developing new battery materials that will be used in later versions of batteries. Machine learning algorithms and quantum simulations make it possible to quickly test thousands of materials, correctly guessing what their properties will be and choosing the best ones to test in the lab. This does two things: it speeds up research and development and makes it possible to come up with new ways of designing things that weren't possible with old methods.

In this age of advanced battery design, quantum computing has the potential to speed up innovation in all parts of the battery value chain, such as the making of raw materials, the making of devices, and the integration of systems. It's possible that quantum computing will completely change how we store energy, shed light on the physics behind batteries, and give experts powerful computing tools. In addition, it can help us move toward a future with more clean energy.

P.S. Ranjit 2014 This research will look at the pros and cons of intelligent battery design with quantum processing and what we know so far about them. It will also look at the risks and possibilities that come with it. The point of this research is to look at how quantum computing has changed battery technology, including where it came from and how it can be used in real life, as well as to make guesses about what the future might hold for energy storage.

Quantum computing is an emerging field of study in computer science that processes data in accordance with the principles of quantum physics. Quantum computers are distinguished from classical computers by their utilisation of quantum bits (qubits) rather than binary bits as their fundamental data unit. The capability of quantum computers to execute multiple calculations concurrently is attributed to the quantum superposition of qubits, which can represent either zero, one, or a combination of these states.

One of the most captivating characteristics of quantum computers is their capacity to execute specific tasks at a significantly quicker rate than conventional computers. Due to their ability to solve complex mathematical problems, such as factoring large numbers, exponentially faster than classical computers, quantum computers have the potential to have a profound effect on cryptography and cyber security.

Nevertheless, the development of operational quantum computers on a significant scale remains unfinished; the discipline is in its early stages of development. Priority is being placed by researchers on the

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