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The Twenty-First Century Elixir

Just a little over ten years ago, smartphones would crack with the slightest bit of extra force. Today, these same phones can take quite a heavy beating without a scratch while still being lightweight, and cost-effective. Most of these features can be attributed to the advancement of gorilla glass. The invention of new types of materials like these has been the backbone of modern civilization. From new fabrics to electronic devices to the development of cheap but powerful medical testing kits all tie down to advances in materials.

There is one particular class of materials that has taken center stage in modern science known as *Metal-Organic Frameworks* (MOFs). These materials can store and absorb gasses like sponges, purify water like a molecular sieve, offer highly precise drug delivery, or advance battery technology. These magic materials have far-reaching applications in every frontier of technology.

The trick behind this material's magic lies in its unique chemistry. As their name suggests, MOFs are made of little sub-units of organic compounds and metal clusters. These sub-units can be stacked like scaffolding with relatively high freedom, allowing scientists to craft large networks with various geometries and topologies. The general feature of a MOF is that it is porous, and has a cage-like structure with a very high surface area. By picking different combinations of organic compounds and metals, combined with the almost limitless freedom in the topology of these materials, MOFs can be tailor-made for any application.

Although MOF materials are relatively new and have only been around since the 1990s, more than 90,000 different MOFs have been synthesized for different unique use cases. Many more MOF designs have been predicted using machine learning models.

Currently, there is also an increasing demand for MOFs to be synthesized as uniform ultrathin films. Most MOFs are synthesized as powders or in bulk form. While useful, it does limit the scalability of the technology. Thin films of MOFs allow for the integration of this material with microdevices, thus furthering advancements in electronics.

In this thesis, I study the growth of ultrathin films of an iron-based MOF. These films are created using a combination of *Atomic Layer Deposition* (ALD) and *Molecular Layer Deposition* (MLD). These are techniques widely used in industry and research, for example, in semiconductor fabrication to grow ultrathin uniform films. Studying

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the deposition and interaction of molecules used to grow the iron MOF furthers a better understanding of the underlying mechanisms and allows for the development of reliable methods to grow uniform films of MOFs.

MOFs lie at the intersection of Physics, Chemistry, and engineering with applications ranging from healthcare and environment to electronics and batteries. These materials's boundless potentials truly make it a modern-day elixir.

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