In the coming years, photonic technologies will be fundamental in both cleaning up our energy sources and driving the digital revolution. Organic photonic materials, made up of special molecules called chromophores, are a big part of this. These molecules get their name from the fact that they often have intense colors due to their interaction with light (Greek *chromos* means color).

Think about the start of the 20th century when dyes and pigments were a big deal for the chemical industry. Fast forward to today, and research in this field has come a long way. We now have functional dyes all around us, from the screens we use to photovoltaic panels and even in medicine.

But here's the catch: We're not tapping into the full potential of these light-based technologies. We're using only about 20% of what they can do, and we're capturing less than 0.1% of the sun's energy reaching Earth’s surface. To unleash their full power, we need to better understand how these materials work and design new chromophores and ways to put them together.

The arrangement of these chromophores is crucial. It decides how they interact with each other electronically, which, in turn, affects the properties of the materials they make up. Scientists have been working hard to come up with new chromophores, but there's a missing piece: We don't have a universal system to study how these molecules interact with each other when they're all packed closely together.

Over the past few decades, researchers have been experimenting with different ways to put these molecules together in structures like rings and chains. These structures have been super helpful in understanding arrays of molecules in excited states, but they have their limits. They're not versatile enough and we can't control their size very precisely.

That's where my ambitious research program comes in. I want to create a versatile platform to help us dig deeper into how these electronic processes happen in organic photonic materials. Imagine this platform as a toolbox that can revolutionize our understanding of these crucial processes, especially in emerging tech areas like new photovoltaics, quantum computers, and big data centers.

Here's the plan: I've divided the program into three parts. The first part is all about building structures where chromophores are stacked on top of each other on rigid molecular platforms. These structures will be super organized, with specific sizes and arrangements of chromophores.

In the second part, we're going to create new building blocks that have a twist: they're chiral, which means they have a unique handedness. These chiral building blocks will help us understand a whole new category of nonlinear optical materials doe optical signal processing and open the door for exciting developments in this field.

Now, in the third and final part, we're bringing it all together. We'll take the tools and knowledge from the first two parts and engineer some pretty amazing structures: multichromophore unidirectional double helices. These structures will be like nothing we've seen before, and we'll explore how they can be used for things like better nonlinear optics and even spintronics, which might be revolutionary materials in quantum computers.

If we succeed in putting all this together, we'll unlock a deeper understanding of how light and matter interact, which could lead to some game-changing advancements in clean energy and digital technology.