

[INAUDIBLE] sensors, so yeah, please.

Thank you. Good morning. Thank you all for coming. So as you mentioned, I'm going to be talking about the disruptive chemical approach to modify perovskites for chemical and biological sensors. So the outline of my talk. I'll be going through the objectives of our project, a little bit of background, the material system, experimental methods, and then our results.

So for our objectives, we had two main objectives. The first one was we were going to disrupt the chemistry of the compound. And then see what effect the disruption has on the electrical characteristics. And then the second objective was to determine the suitability of the electrical properties of perovskites for the chemical and biological sensing.

So the material system we used was NCTO. CCTO is the well-studied perovskite material. So as I mentioned, CCTO is a very good perovskite material. It has a high dielectric constant. And what we did was we changed the calcium ions and replaced them with sodium. And so because of this, the valency and the size of the compound was changed.

And what we wanted to look at was then how the dielectric and other electrical properties were changed as a result of this disruption. So like Dr. Singh mentioned earlier, normal materials right now have a dielectric of around 20 to 30. But the dielectric that we're working with was way higher, around 10,000. So this is the structure of a perovskite, the cubital structure. These materials typically have dielectric of around 20 to 30.

And then what we did was we changed the calcium, which you can see in the yellow, with sodium. So why do these materials have such a high dielectric constant? There are a few theories. There's controversy in the reasoning behind it. It might be due to intrinsic factors, such as the polarity or it might be due to extrinsic factors, such as the crystalline structure. However, it's still controversial.

OK, so our experimental method was that with the NCTO, what we did was we first prepared the sample. And then after that, we characterized the material to find the dielectric constant and the resistivity. And then we also looked at the morphology through SEM. So for the synthesis, we use sodium, instead of calcium. And we use the stoichiometric ratios above. And then we use materials with 99.9% purity.

And we made a powder. And then what we did was we pressed the powder into a pellet using a pressure of 700 to 800 pounds per inch squared. And then we annealed the

pellets at a temperature of 600 degrees Celsius, followed by 750 degrees Celsius. And then we studied the morphology using an optical microscope and scanning electrical microscopy.

So these were the materials that we use. And then those are the actual weights that we used. And then this was what they looked like when we made the powder. And what we did was we split the powder into two so that we could have pure pellets of just NCTO. And then we could also have pellets that we would treat with another chemical.

So after we had our pellets made, we used a LCR meter to determine the capacitance and resistance. What we did was we took a silver dot and put it on both sides of the pellet. And then place the pellet in between a parallel plate capacitor. And then we use a frequency from 100 Hertz to 100 kilohertz to determine the capacitance and resistance.

And then again, this is just the exact amount of time that we had the pellets in the oven for. And then the exact mass that was used to make the pellets. And then these are what our pellets look like. And then this was the machine that we used to make the pellets. And then this is the picture of the pellets before it was placed into the oven. And then these are the annealed NCTO pellets. So the color did change after they were annealed, OK.

And then this was a picture of the microstructure of the NCTO pellet. So there's a lot of nanorods and then aggregates of the nanoparticles. This is a more magnified SEM picture. You can see the nanorods and the aggregates of the nanoparticles. And then this was the furnace that we used and the LCR meter.

And so to determine the dielectric constant and the resistivity, we use the capacitance and resistance measurements from the LCR meter. And then these were the dimensions that we use in the calculations that we had. And so then this is the resistivity of pure NCTO. So this is-- you can see that as the voltage increased, the resistance decreased.

And then this is showing us the dielectric constant. So this one is the lowest frequency, had the highest dielectric constant. And then as the frequencies decrease, the dielectric also decreased. And then this is the dielectric constant as a function of frequency, if we just plotted it in a logarithmic scale. So you could see it in a different way.

And then here, we have the doped pellets. So this purple line here is the pure NCTO pellet. And then this green line is the nitrate-doped pellets. So the resistive was way higher than the pure pellet. And then this orange line was the pellet with acetone. So that one, the resistivity was lower. And then this one, we were looking at the dielectric.

Again, this purple line is the pure dielectric constant of the pure NCTO. And then this green line is the nitrate-doped dielectric. So we can see that the dielectric was way higher. And then the orange line was with acetone. So both of those acetone and nitrate-doped, dielectrics were both higher. So from this, we can see that doping these chemicals with another substance is a basis for sensing, since the dielectric and resistivity was significantly changed.

So in summary, we studied NCTO extensively. And we found that it had a dielectric up to 10,000 in the megahertz range. And then we did see that the resistivity and dielectric constant were significantly changed when they were in the presence of other chemicals, as we saw with the nitrate-doped. And then going further, we would study the hetero-valency and the size of atoms using other atoms as well. Thank you.

[APPLAUSE]