Hello, everyone, my topic today is simulation and optimization of piezoelectric circular energy harvester.

First, I want to give a brief introduction about piezoelectric effect. Piezoelectricity effect is that when certain kinds of solid materials are applied pressure, their interior will be polarized. The same amount but with opposite sign charges will be generated on the opposite surfaces. These spatially-separated kind charges will form an electric field. By connecting the exterior circuit, the mechanical energy (caused by applied pressure) will be harvested and change into electric energy. However, its reverse effect can convert electric energy into mechanical energy.

By virtue of this effect, it can realize the conversion between mechanical energy and electrical energy.

In fact, the piezoelectric materials are very common in daily life, such as lighter and the transducers in ultrasonic devices. Right is a picture about piezoelectric circular diagram energy harvester, which is lighting a LED lamp. And there is a video, I’m wondering whether it can be played smoothly though the zoom. Let’s try it.

One problem of current PZT circular diagram (PCD) energy harvester is inhomogeneous output distribution on the PZT ceramic surface. You can see in the figure, central area contributes most of the output while the output of the edge area is very low.

Thus, I design a notched PCD energy harvester aiming to increase the output on the edge area.

Right is schematic diagram of the test platform and regular unnotched PCD energy harvester. (Parameters are based on a real experiment)

Left is notched PCD energy harvester

The energy harvesters were modeled in SolidWorks first, and the FEA analysis section was completed in Abaqus due to it outstand performance in electrical analysis. More details about modeling and FEA analysis procedures are in the term paper.

This is the qualitative comparison of effective charge density distribution among PCD harvester with different amounts of notches. We could see the color around the notches turn deep.

To show it more clearly, here is the quantitative comparison. As we could see, OM direction shows a remarkable increase of electrical charge density in the edge area of notched brass substrate. And the Total increase is up to 1.3 times.

As for the future use, I designed a PZT energy harvest array which can absorb vibration mechanical energy caused by vehicles and passengers and convert them into the electrical energy to support the future sensors integrated in the internet of things road and the connected world.

I heard about solar cell used in such road, but it is hard to balance the transmmitance and strength

Energy conversion efficiency of the solar cell is very low，about 20-30%, and its cost and maintenance fees is very high

To be honest. Its part of my senior projects in my undergraduate school. But that time I only learned the basic concept of FEA analysis and the operation of abaqus that time. It just like I know how to use the tools but I don’t know how it was invented. So I regard this is an opportunity to recover the theory details I didn’t understand that time