



# HACETTEPE UNIVERSITY

## DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

### ELECTROHYDRODYNAMIC DIRECT-WRITING TOOL

Tolga AKÇA, Yusuf Yiğitbaşı  
Supervisor: Assoc. Prof. Dr. Dinçer GÖKCEN

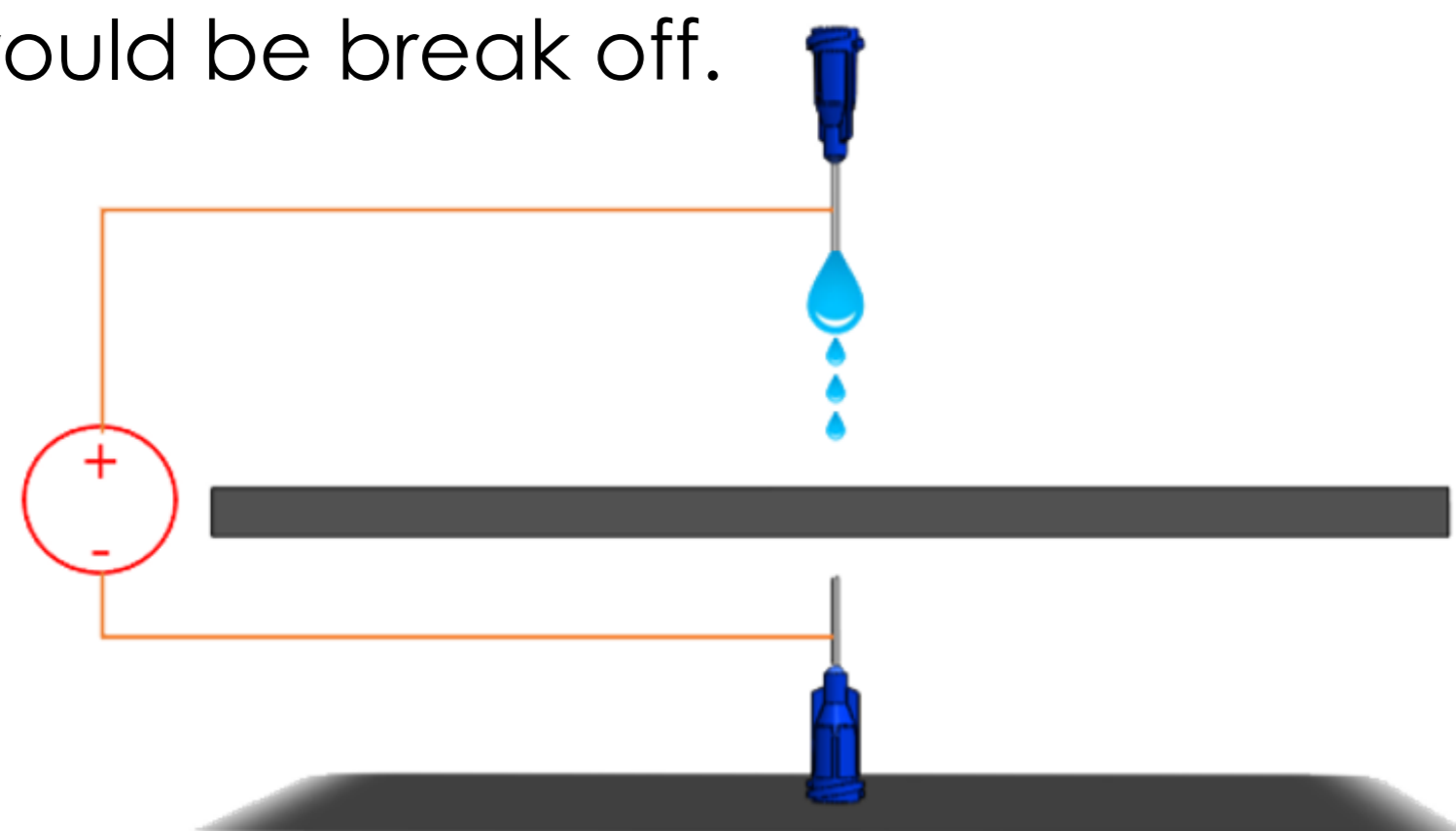
#### INTRODUCTION

Electrohydrodynamic (EHD) direct writing is a cost effective and high efficiency solution. This is a pull process that can be considered as an extra electric field is applied between the nozzle and substrate. There are three modes of EHD printing which are e-jet printing, electrospinning and electrospraying which is adjusted by applied voltage, electrode distance and material types and pattern. This technique can be used for writing micro/nano wires, fabrication of high performance organic electronics, for instance organic field effect transistors, flexible sensors, stretchable energy harvesters.

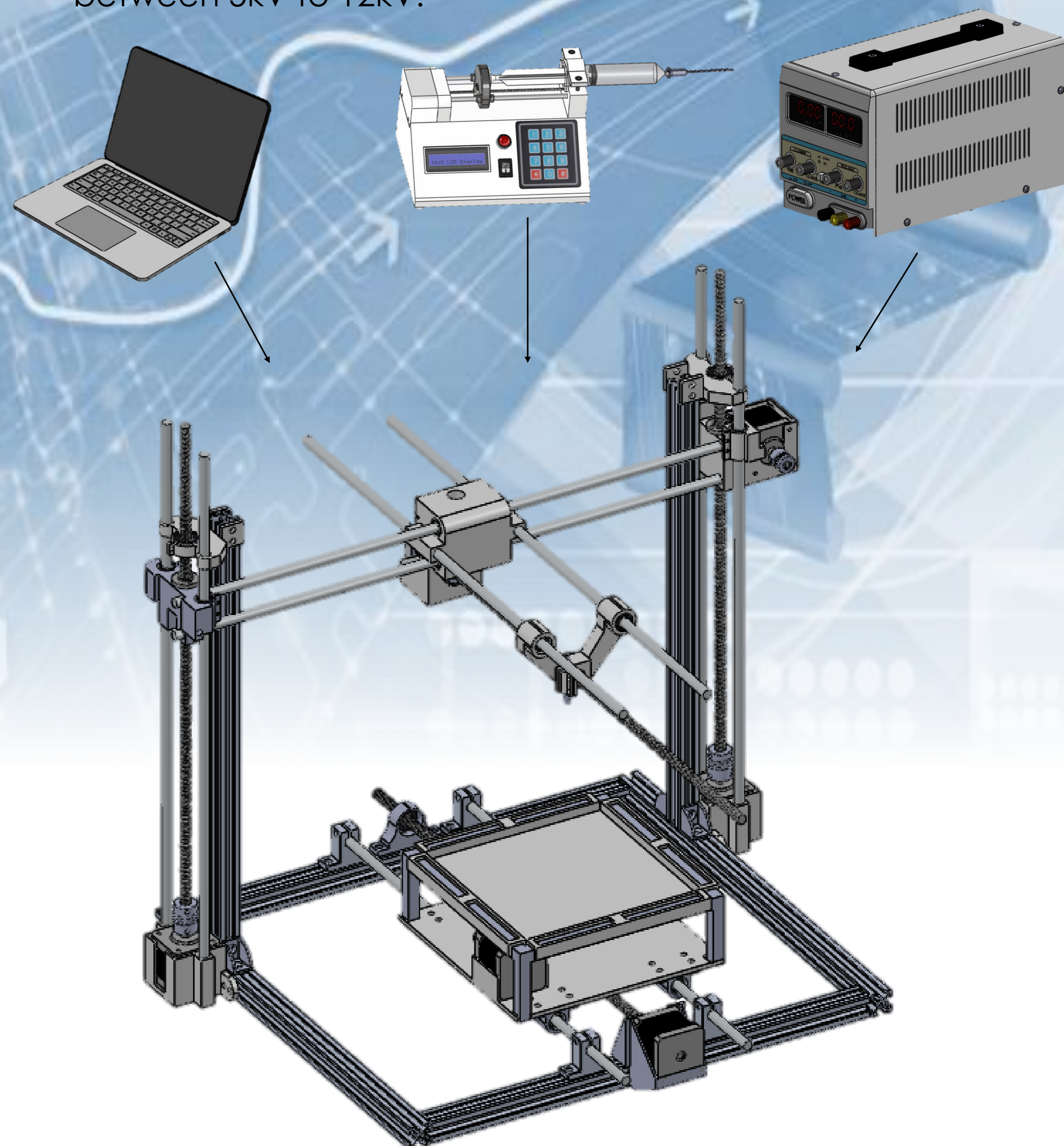
EHD printing is a complex process that mechanical process parameters such as movement speed and pressure pump speed works with harmony. In our experiments, pressure pump speed is adjusted between 10  $\mu\text{m/s}$  and 100  $\mu\text{m/s}$ . As well as applied voltage varies between 5kV to 12kV.

#### WORKING PRINCIPLE

EHD tool is capable of moving in XYZ dimensions. There is a substrate between two nozzles, upper nozzle is used for dropping the ink, as lower nozzle is used for grounding as well as improving the resolution and sensitivity of ink. To overcome the strong cohesive bond between ink molecules, high voltage is applied between the two needles. An electric field occurs between the needles, the electric force is pushing the nanoparticles. The nanoparticles in the ink will be attracted to the substrate with high force. As you can see from figure below, at the tip of upper needle Taylor cone is forming. If the electric field due to the voltage differences is high enough, the particles would be break off.

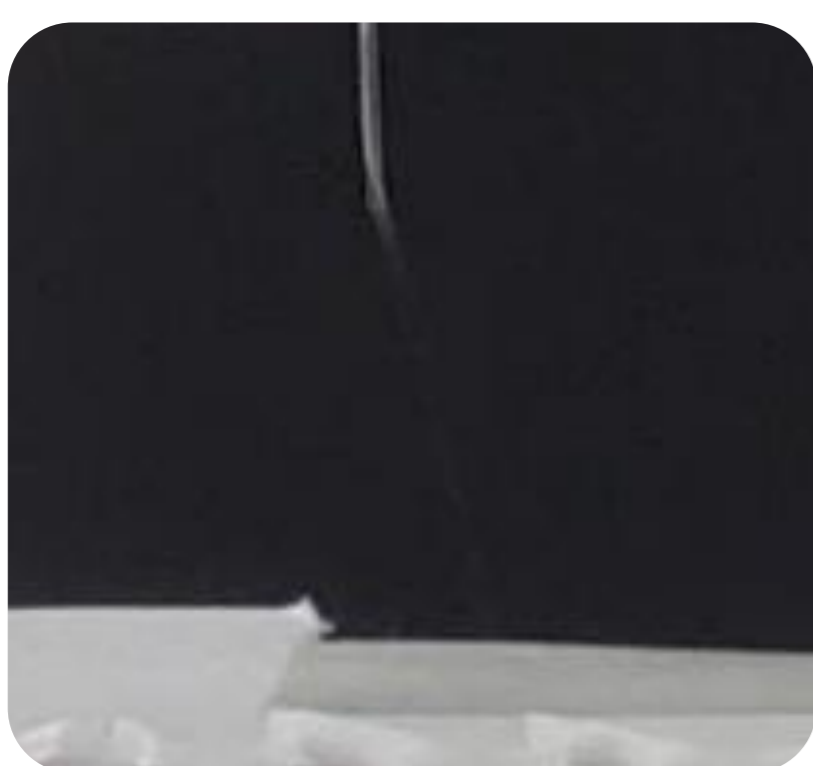


EHD Direct Writing



Procedure Schematic

#### RESULTS



Special Thanks to Dr. Cem Bayram, İbrahim Bozyel ve Boğaç Kılıçarslan