An Electric Spark Scalpel

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The problem of blood loss is actual in any surgical operation. Nowadays, this issue is solved by huge and expensive devices. My goal was to create a mobile medical instrument able to make thin cuts without bleeding by using an electric spark. I made a high-voltage power supply and explored the movement of electric arc in the air. Analyzing more than 2000 photos showed that the trajectory of the arc is very unstable, because the Coulomb forces in the arc always exceed the Ampere forces. Moreover, the ratio between the atmosphere pressure and the interior area pressure of the arc is also changeable. To focus the arc and decrease the thickness of the cut I offered to use a dielectric wedge. Induced charges appear in the wedge attracting the arc. As a result, it spreads along the surface of wedge by one and the same path thus providing the required precision. The wedge shape orders the arc to turn on its tip where the extremely high temperature occurs. At this point the arc cuts soft tissue and adheres blood vessels simultaneously. Charring the area up to 2 mm around the incision fully complies medical requirements. An electrical schematics of the instrument includes a high-voltage pulsed converter and timer allowing regulation of the discharges repetition rate. The circuit is placed in a compact case and is powered by an external 12 V source. The current of the arc is about 3mA that is safe for human organism. Nozzles that form the arc can be removable to simplify the sterilization and to perform various types of operations. To test the operability of my method I made some experiments with materials simulating biological tissues (paper, polyethylene). They proved that surgeon can make both continuous cuts and make 10 um holes in tissue with this scalpel.

Awards Won:
China Association for Science and Technology (CAST): Award of $1,200