Novel Chemical Doping Strategy to Enhance N-Type Organic Electrochemical Transistors

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Organic electrochemical transistors (OECTs) are among the most powerful transistors to date by combining both ionic and electronic conduction. This unique mechanism makes these devices desirable for implantable bioelectronics in the human body, particularly as biosensors, deep brain stimulators, pacemakers, and artificial muscles, reducing reliance on invasive medical procedures. However, electron-conducting (n-type) OECTs, suitable for bioelectronic applications, historically suffer from instability and low performance, limiting their practical application. Chemical doping was investigated as a novel and cost-effective method to enhance device performance, successfully identifying a new dopant and unique doping techniques. Various organic salts were explored as potential dopants because of their strong Lewis base makeup. Current-voltage tests and electrochemical impedance spectroscopy characterized and compared undoped and salt-doped n-type OECT performance. Doping with tetrabutylammonium chloride (Bu4NCl) salt improves the device's transconductance, mobility, signal-to-noise ratio, threshold signal, and capacitance. The Bu4NCl dopant's statistically significant improvements in metrics yield a 97% improvement in amplification and a 77% improvement in switching speed and charge storage. Doping with Bu4NCl is optimized at a concentration of 20 molar percentage and a solvent blend of chlorobenzene to chloroform at a 1:5 ratio, enabling the salt to promote charge transfer and delocalization in the polymer network. Bu4NCl is identified as a new dopant to fabricate n-type OECTs with high performance. This study is the first to explore dopants, doping concentration, and solvent design in conjunction, advancing chemical doping in tailoring OECTs to become commercially viable.

Awards Won:

George D. Yancopoulos Innovator Award