

Integrated Resistor and Capacitor  
Fabrication for Next Generation  
Microsystems

B. A. Tuttle, D. P. Williams, P.G. Clem,  
and J. Cesarano, III  
Sandia National Laboratories,  
Albuquerque, NM 87185

Miniaturized, high energy density resistors and capacitors are needed to enhance performance of new micro-systems for both fuel cell vehicle and defense applications. An important development is the integration of high sheet resistance resistors on novel substrates to improve overall system performance. Specifically, we have fabricated 2 mil line width, 1 megohm per square resistors using the direct write process of aerosol jetting on alumina and Kapton substrates. Aerosol jetting requires the formation of a mist of 2 to 5 micron droplets from commercial resistor inks. The aerosol jetting process results in finer resistor line widths and excellent edge definition compared to present screen printing processes. Resistors were fabricated using 1 megohm per square ink and exhibiting 5 kW/cm<sup>3</sup> power densities.

Presently, capacitors occupy more volume than any other set of components in many power systems, such as, pulse power supplies for defense applications and inverters for electric hybrid and fuel cell vehicles. Thus, development of integrable, higher energy density, higher operating temperature dielectrics is being investigated to substantially reduce system size and to enhance performance. Using the direct write technique of robocasting (Fig. 1) we have fabricated high quality, high Zr content lead lanthanum zirconate titanate (HZPLZT) dielectrics. These materials have dielectric constants ranging from 2000 to 5000 that exhibit minimal temperature and field sensitivity and are low loss. The impact of processing on Robocast and conventionally formed HZPLT dielectric properties is emphasized in this presentation. Sandia is a multiprogram laboratory operated by Sandia Corp., a Lockheed Martin Company, for the U.S. Department of Energy, under contract No. DE-ACO4-94AL85000.

Fig. 1. Three nozzle robocaster for multi-material direct write fabrication

