Polymer-derived ceramic is a new kind of material which is directly synthesized by the thermal decomposition of polymer precursors. Due to their unique structure, which consists of amorphous matrix phase and free-carbon phase, PDCs exhibit many distinguished properties even at high-temperature environment such as oxidation and creep resistance, high tensile strength, as well as piezoresistive behavior. These outstanding properties make PDCs become promising candidates for various applications especially for high-temperature microsensors. But now, most attentions are given to the non-oxide PDCs such as SiC, SiCN, and SiAlCN. Not only the cost of their raw materials are expensive, but the requirement for operating environment is also very strict. Therefore, some new kinds of PDCs are urgently needed.

Recently, SiCO ceramics are appealing increasing attentions because of several reasons. Firstly, the raw materials for SiCO ceramics are commercial available at a low price, which reduces the economic cost for both laboratorial researches and manufactory fabrication. Secondly, due to the existence of large amount of oxygen in themselves, the requirements for operating and storage environment also become softer. Last but not the least, most polymer precursors for SiCO are silicone resins, which are non-toxic for human and eco-environment. Meanwhile, previous researches reveled adding Al into existing PDC systems can improve their oxidation and corrosion resistance. Therefore, SiAlCO ceramics are ideal materials for further applications.

In this dissertation, the SiAlCO ceramics are synthesized by using silicone resin as polymer precursor and aluminum tri-sec-butoxide (ASB) as modifier, then ceramic samples can be obtained by pyrolyzing green bodies at 1000, 1100, 1200, 1300, 1400 degree C, respectively. The structure and structure evolution of SiAlCO ceramics are characterized via Xâ€“Ray diffraction (XRD), Raman spectroscopy, Xâ€“ray photoelectron spectroscopy (XPS) and Impedance spectroscopy (IS). Then analyzing all the results above, the conduction mechanism of the material can be well explained. Moreover, combining temperature-dependent conductivities measurement and optical absorption measurement, important parameters such as conduction band, band-tail, defect energy, and Fermi energy can be determined, and then the electronic structures of SiAlCO ceramics are also obtained.

In addition, SiAlCO ceramic also exhibits extraordinary piezoresistive behavior. The sample is tested under a uniaxial compress spring tester, and its resistance is measured by recording its I-V curve. The material shows a very high gauge factor at room temperature in range of 7000 ~16000, which is higher than that of any other reported materials. The piezoresistive behavior is also tested at high-temperature up to 300⁰C and the gauge factor increases with increasing temperature. This is fundamentally different from those reported previously for polycrystalline materials and PDCs. In the end, a simple stress-sensor is fabricated successfully.
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The public is welcome to attend.