

## Structure Behaviors and Phase Evolution of Lead Zirconate Titanate

### Ceramics Prepared by Sol-Gel Processing

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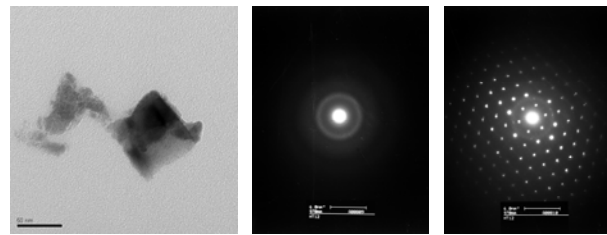
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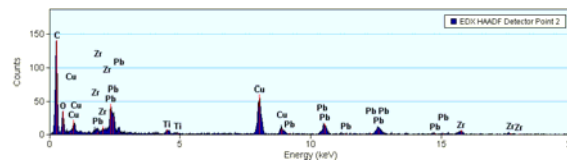
Lead zirconate titanate (PZT) (53/47) powders were fabricated by the alkoxide-based sol-gel process, and the different drying times (1h and 12h) at the pyrolysis temperature (300°C) of lead acetate were studied. The different pyrolysis time before calcination affects the onset and the violently dominant decomposition temperatures of lead acetate. According to the estimated activation energy results, the 1h pyrolysis time showed that the transformation of the pyrochlore to perovskite phase is nucleation-controlled (424.5kJ/mole), but the 12h pyrolysis time is growth-controlled (125kJ/mole). It was also found that the relative PZT perovskite contents were controlled by the carbonaceous material contents within the dried gels and the release rate of hydrocarbon during the pyrolysis process. With the proper pyrolysis-treated PZT powders, the dense, phase-coexisted PZT bulks could be produced at a low sintering temperature of 950°C and 1000°C. The phase transformation of the PZT ceramics changed from the rhombohedral phase (900°C) to rhombohedral and tetragonal phase coexistence (950°C and 1000°C), then finally to the monolithic tetragonal phase (1050°C and 1100°C). A phase diagram is plotted based on the different sintering conditions. The dielectric properties were dependent on the relative densities of the PZT bulks, and the PZT bulks sintered at 1000°C for 6h had superior dielectric constant (1080) and lowest dielectric loss (0.7%).

#### References

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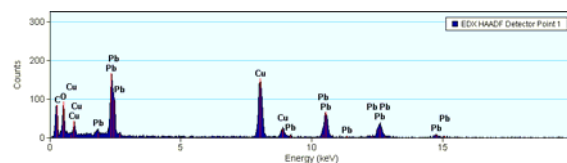


(a) (b) (c)



Element	Weight %	Atomic %	Uncertainty %	Detector Correction	k-Factor
O(K)	16.512	67.187	1.259	0.514	1.980
Ti(K)	2.310	3.140	0.445	0.985	1.299
Zr(K)	10.434	7.446	1.397	0.999	3.927
Pb(L)	70.742	22.225	3.681	0.753	6.527

(d)



Element	Weight %	Atomic %	Uncertainty %	Detector Correction	k-Factor
O(K)	15.157	69.822	0.792	0.514	1.980
Pb(L)	84.842	30.177	2.406	0.753	6.527

(e)

FIG. 1. (a) TEM morphology of the H.T 12 as-pyrolyzed powders, and the diffraction patterns of the bright particle (b) and dark particle(c).The EDS results for the bright particle (d) and dark particle (e).

Table 1 Activation energies of various reactions for H. T 1 and H. T 12 dried gels

Reactions	Reactions	* H. T 1 (kJmol <sup>-1</sup> )	H. T 12 (kJmol <sup>-1</sup> )
Formation of PbO	$\text{Pb}(\text{CH}_3\text{COO})_2 \rightarrow \text{Pb}(\text{CH}_3\text{COO})_2 \cdot \text{PbO}$ $\rightarrow \text{Pb}(\text{CH}_3\text{COO})_2 \cdot 2\text{PbO} \rightarrow \text{PbO}_{1-x}(\text{CO}_3)_x$ $\rightarrow \text{PbO}$	56.2±2.7	77±2
Formation of pyrochlore	$\text{PbO} + (\text{ZrO}_x)_{\text{amorphous}} + (\text{TiO}_x)_{\text{amorphous}} \rightarrow$ Pyrochlore	351.4±19.5	122±1
Formation of perovskite	Pyrochlore $\rightarrow$ perovskite	424.5±23.6	125±4