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## Effect of K/Na ratio on Piezoelectric Properties of Modified- (K<sub>1-x</sub>Na<sub>x</sub>)NbO<sub>3</sub> “Hard” Lead-free Materials

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Lead-free ceramics with a composition of 0.55 mol%K<sub>4</sub>CuNb<sub>8</sub>O<sub>23</sub>-(K<sub>1-x</sub>Na<sub>x</sub>)NbO<sub>3</sub> (KCN-KNNx) where  $0.45 \leq x \leq 0.60$  were synthesized by conventional ceramic processing. Results revealed that the addition of Na was effective in changing the microstructure and relative density of KCN-KNNx. Further, the addition of Na resulted in a slight shift of the phase transition temperatures (T<sub>o-t</sub> and T<sub>c</sub>) toward low values. A high mechanical quality factor (Q<sub>m</sub>) of 1850 was found at  $x=0.54$ , which might be due to the build-up of an internal bias field (E<sub>i</sub>) within KCN. Thermal hysteresis in KNNx was confirmed with an increase in the Na content during the heating and cooling cycles, resulting from structural changes. Thus, KCN-KNNx with  $x=0.54$  exhibits excellent piezoelectric properties with d<sub>33</sub> (97 pC/N), k<sub>p</sub> (36%), and Q<sub>m</sub> (1850), being promising candidates for application in high-power piezoelectric devices.

**Keywords:** Lead-free, Piezoelectrics, (K,Na)NbO<sub>3</sub>

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## CNG 연료탱크의 내압상승시 발생하는 음향방출 변수들의 분포

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자동차용 CNG 연료탱크의 복합재료 중앙부 표면에 150 kHz 공진형 음향방출센서를 부착하고, 물을 매질로 하여 용기의 내압을 단계적으로 상승시켜 가면서 각 단계에서 일정시간 압력을 유지시키고 그 때 발생하는 음향방출신호를 획득하였다. 이 때 획득한 음향방출신호의 amplitude, count, duration 및 risetime 등과 같은 음향방출 변수들의 분포를 살펴본 결과 복합재료 압력용기의 손상메커니즘을 추정하고 손상정도를 평가하는데 유용하였다.

**Keywords:** Acoustic emission(음향방출), Fuel tank(연료탱크), Distribution(분포)