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(54) **EARTH-ABUNDANT DOPANTS FOR
PIEZOELECTRIC ENHANCEMENT IN
WURTZITE CRYSTALS**

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(57) **ABSTRACT**

Doped-AlN piezoelectric materials are advantageous because they are far more compatible with complementary metal oxide semiconductor (CMOS) materials and they maintain both piezoelectric and thermodynamic stability up to very high temperatures, compared to PZT. Ab-initio calculations and targeted experimentation have identified alternative, earth-abundant, dopants for AlN from the periodic table d-block. In particular, group IVB elements, titanium (Ti), zirconium (Zr), and hafnium (Hf) induce large piezoelectric enhancements comparable to rare-earth dopants, such as Sc. This improvement is due to shifts in the sublattice atomic structure and changes in the local charge states. This invention provides a highly accessible and affordable path for technological adaptation of AlN-based piezoelectrics for sustainable, next-generation electronics.

