Development of Novel and Cost-Effective Perovskite Photoconductive Micro-Device for Terahertz Emission Applications

Jadaa, Retal (School: Jeddah Gifted School)

Terahertz (THz) photoconductive devices are one of the most promising devices that allows a relatively high signal-to-noise ratio and perform fast scan for imaging, spectroscopy, and ultrafast communication applications. The THz emitter is an optoelectronic device that can produce broadband (and non-ionized) electromagnetic radiation of (0.1 – 10 THz) using III-V semiconductor materials. This study aims to develop a novel cost-effective alternative material with THz emission convenient characteristics: short carrier lifetime, high breakdown voltage, high carrier mobility, high dark resistivity, and high stability\ durability. Metal halide organic lead iodide perovskite was prepared by a solution-processed lead iodide perovskite using a spin-coating on a fused silica substrate. To overcome the perovskite stability issue, different thicknesses of Al2O3 passivation thin film were sputtered. This perovskite's passivation layer may diminish the humidity influence and enhance stability. The perovskite optical absorption, crystallinity, carrier lifetime, and device emission were characterized using photoluminescence (PL), X-ray diffraction (XRD), pump-probe measurements, and terahertz time-domain spectroscopy. The results showed that the improved perovskite material's crystallinity remained stable under high humidity due to the deposited Al2O3 layer. The developed perovskite material emitted up to 2.8 THz emission because of the short carrier lifetime less than 20*10-12 s (20 picoseconds). These findings can play a crucial role in using alternative low-cost and high-efficient photoconductive materials for the application and integration of affordable broadband THz sources.