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Terahertz Technologies for Wireless Communications: Achievements and Future Directions

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Terahertz (THz) technologies have long been driven by advances in materials and device physics, leading to remarkable progress in sources, detectors, and functional components. However, the transition from individual device demonstrations to practical wireless communication systems remains a critical challenge.

In this talk, we review recent progress in THz devices and circuits and discuss their impact on emerging wireless communication applications beyond 6G. System-level integration—scaling, packaging, and co-design—is crucial for maximizing output power, sensitivity, and energy efficiency.

We argue that opto-electronic convergence offers a promising pathway to overcome fundamental limitations of purely electronic or photonic approaches. Figure 1 demonstrates the integration of materials, device physics, and system architectures through heterogeneous approaches, facilitating advanced functionalities and improved performance. This integrated viewpoint clarifies the importance of co-optimizing digital, analog, and photonic domains to achieve scalable THz wireless systems.

Finally, we present a forward-looking perspective on the key challenges and opportunities, and outline how the community can move toward fully integrated THz wireless systems.

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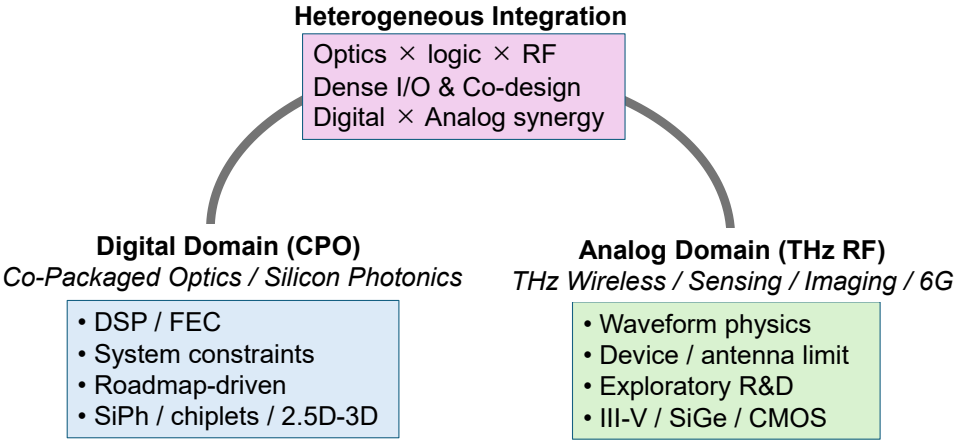

Fig. 1 Conceptual diagram illustrating heterogeneous integration across optics, logic, and RF domains, highlighting the co-design requirements for future THz wireless systems.