Ceramics Characterisation by Terahertz Technology

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Over the past two decades THz technology has attracted tremendous interest in the fields of information and communications technology, biology and medical sciences and, non-destructive evaluation. However, the lack of THz materials with *simultaneous* ultra-low-loss and high dielectric permittivity, with reduced dispersion, is a major constraining factor in the future development of THz technologies, particularly for planar integrated THz-on-chip systems. Conventional dielectric ceramics such as TiO_2 are intrinsically attractive for meeting technical requirements. Being less-dispersive and having a broadband high permittivity, they naturally lend themselves to low-cost, compact, planar-substrate integrated THz components and systems in microelectronics processing. In THz telecommunication systems, TiO_2 affords wide-band operation with low dielectric loss and this translates into supplying of a viable power budget for operating THz systems having a usable dynamic range, since available THz output power is to-date limited and precious (typically being in the range of 10s – 100s of microwatts).

Systematic research has been undertaken to explore the connections between material microstructure of ceramics and their intrinsic THz dielectric properties such as their dispersive loss and permittivity response, since there is a paucity of such data to be found in the open literature. In this presentation we report TiO_2 prepared by successfully engineering the porosity, second-phase, crystallographic shear-planes and oxygen vacancies during sintering. The dielectric loss achieved here is not only with negligible dispersion over the 0.20 - 0.80 THz band, but also the lowest value for known high permittivity dielectrics. This broadband, high-permittivity, reduced-dispersion and low-loss and low-cost material, constitutes a step-change in improving gigabit-rate data transmission for communications. This work will be of broad interest to research communities covering THz, materials, electronics and communication.