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Design principle of gradient structure for promoting better heat transfer between highly mismatch materials

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ABSTRACT

With the miniaturization of devices and the sharp increase of power density, the problem of heat dissipation has become a technical bottleneck to improve the performance of high power devices such as large scale integrated circuits, semiconductor lasers and active phased array antennas. Both Cu and diamond are excellent heat management materials due to their high thermal conductivity, however the Cu/diamond interface limits entire thermal performance since they have significant difference in acoustic properties, such as Debye temperature, acoustic impedance, acoustic speed and so on. A widely used method is to add an appropriate interlayer in order to bridge acoustic mismatch between two highly dissimilar materials and enhance heat transfer capacity. Unfortunately, at present, neither is there a clear criterion to choose interlayer with the bridging effect. Therefore, design principle of gradient structure beneficial to interfacial thermal conduction between highly mismatch materials is urgently need so that we provide a prediction for interfacial thermal conductance of a sandwich structure at the cost of minimal computation and experiment. In this work, we inserted different metal interlayers into between Cu and diamond and then measured interfacial thermal conductance of the Cu/interlayer/diamond structure by time domain thermoreflectance (TDTR) technique to explore the design principle of gradient structure.

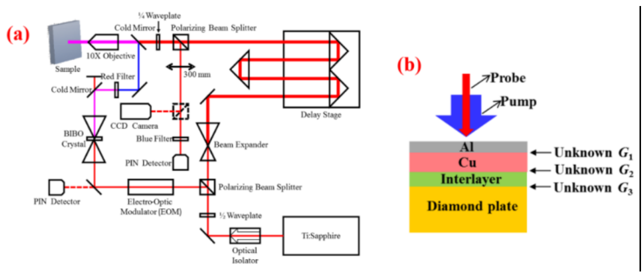

Fig. 1 (a) Schematic of key components of a time domain thermoreflectance system, (b) Structure of multilayer samples.

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