MODELING OF REACTIVE OXIDE BRAZE JOINING OF CERAMIC TUBES WITH A MILLIMETER-WAVE BEAM SOURCE

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We have been exploring the use of a high power, CW gyrotron in processing of materials. One of the more promising uses of this beam system is in the joining of high temperature ceramics, as the beam system permits controlled, localized energy deposition, allowing selective heating of the joint region without heating of the bulk of the materials being joined or the tooling or fixturing used in joining. Effective design of joining processes and selection of process parameters requires either costly and inefficient empirical studies or accurate modeling of the joining process. Accurate modeling of the beam interaction with candidate materials, e.g., ceramic components and fixturing, in the actual experimental configurations can give significant insight into the field and power distribution within the material. From these field assessments, heat generation within the material can be determined and coupled with thermal transfer analysis to provide predictions of joint, component and fixture heating. In this paper, we discuss a method of evaluating the time-dependent temperature profile of a set of concentric ceramic cylinders and fixturing as used in our joining method development. Both solid cylinders and tubes have been analyzed. In this model, the region being heated by the gyrotron beam is treated as a composite system comprised of cylinders of dielectric material having different dielectric and thermal properties, where we include the temperature dependence of the properties. Theoretical results from this model will be compared to qualitative experimental results from our current research into the joining of ceramic cylinders using the 83 GHz gyrotron-based material processing system at NRL.

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