ENHANCING DIFFUSION BONDING

Popular Science Article

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Diffusion bonding is a welding method in which two or more separate components are joined together. One of the key challenges in this process is to achieve strong, defect free joints while using short production times.

In this process, components to be bonded, are first placed in contact, on top of each other, and later taken into a diffusion bonding oven. Here, high pressure and temperature are applied for a specific bonding time. During this time, atoms from one component migrate (jump) to another component, creating very strong joints.

This study investigated, how introducing energy into a material can enhance the bonding quality. In order to assess the quality of the bonded joints, the percentage of defects at the interface was considered together with the percentage of regions where material migrated from one component to the other through the interface. Fewer defects at the interface and a higher percentage of migrated regions are associated with improved joint quality, and thereby with a stronger joint.

When energy is introduced into the components, atoms move faster across the interface, and stronger joints are obtained. In order to introduce energy into the components, these were first deformed using a press. Applying a high deformation ratio automatically introduces more energy into the materials. After energy introduction, these components were taken into the oven, where bonding happened.

Experiments conducted in this study demonstrated the effectiveness of introducing energy into the material, showing that the bonding quality significantly improved in previously deformed materials. For these materials, not only did the interfacial defects reduce, but the percentage of migrated regions across the interface also increased, further increasing the bonding quality.

Moreover, it is also known that a high bonding temperature can change the microstructure of the material by reducing the amount of pathways for atomic movement. Consequently, using a lower bonding temperature could mitigate this microstructural change. Therefore, the mircorstructural evolution of the components was compared at higher and lower temperatures. It was observed that at high bonding temperatures, these pathways in the components reduced significantly, whereas the microstructure did not change at lower bonding temperatures. This finding suggests that lowering the bonding temperature could further enhance bonding quality by preserving pathways in the components.

In summary, this study concluded that introducing energy significantly enhanced joint bonding quality. Additionally, it suggests that lowering the bonding temperature could further improve bonding quality while simultaneously decreasing production time and cost.