Joining of polymer components via sputter deposited reactive multilayer systems

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Abstract

Constant developments in the field of micro-electronics for the rapid growing consumer market require advanced micro-joining technologies. A serious contender for this role is joining via reactive multilayer systems (RMS). The self-propagating reaction of the RMS, which consists of alternating sputtered layers of different materials, e.g. Nickel and Aluminium with an individual layer thickness of t_{Ni} = 40 nm and t_{Al} = 60 nm, can be used to join different components in a very short amount of time without the need of an additional external heat source. Commonly, RMS are used as a foil in combination with solder foils for joining metal or ceramic components. In this work a directly sputtered polymer is joined with a non-sputtered polymer component without any use of solder foils.

By addressing the occurring challenges such as temperature exposure and thermal stresses of the polymer substrate during the sputtering process, serious problems like the reduction of the duration of the temperature exposure and the area of the heat affected zones can be solved by using RMS technology.

Prior the deposition and joining of RMS, high temperatures and thermal stresses during the sputtering process need to be addressed by changing the parameters of the sputtering system or using a previous surface treatment.

With the proper choice of parameters and surface treatments the polymers were successfully joined via RMS. It could be shown that RMS with thicker bilayers and a higher joining pressure resulted in a higher tensile shear strength.

With a total thickness of t = 2 µm and a bilayer number of n = 20 it was possible to achieve a tensile shear strength $\tau_{tensile} \leq 1$ MPa. The application of sputter deposited multilayer systems on complex shaped 3D-geometries is part of this ongoing work.