A NEW PARADIGM IN FUNCTIONALLY GRADED ADHESIVES

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To fully realize the benefits of advanced composites, mechanical fasteners must be supplanted by more efficient technologies such as adhesive bonding. The promise of functionally graded adhesives to provide particularly high levels of performance in this context has been recognized for decades, but a means of generating stable, high performance adhesive joints with arbitrary gradations in mechanical properties has proved elusive.

We report on a new means of realizing such materials in practice, with a focus on the generation of high performance epoxy thermosets with arbitrary gradations. This is accomplished via the creation of so-called “dual cure” resins that may be crosslinked thermally in order to stabilize the joint and realize a baseline level of performance, then selectively irradiated to locally alter levels of crosslinking and performing and induce arbitrary gradations in properties as a result (Figure 1).

A number of different families of dual cure resins have been explored and are introduced here, as well as data concerning changes in thermal and mechanical performance as a function of the details of the dual curing process. Preliminary efforts giving evidence of the generation of stable functional gradations in practice are also described. Ongoing and future efforts are focused on the optimization of these systems and the incorporation of their cure-dependent mechanical behavior into simulations in order to select appropriate designs for functionally graded adhesive joints.

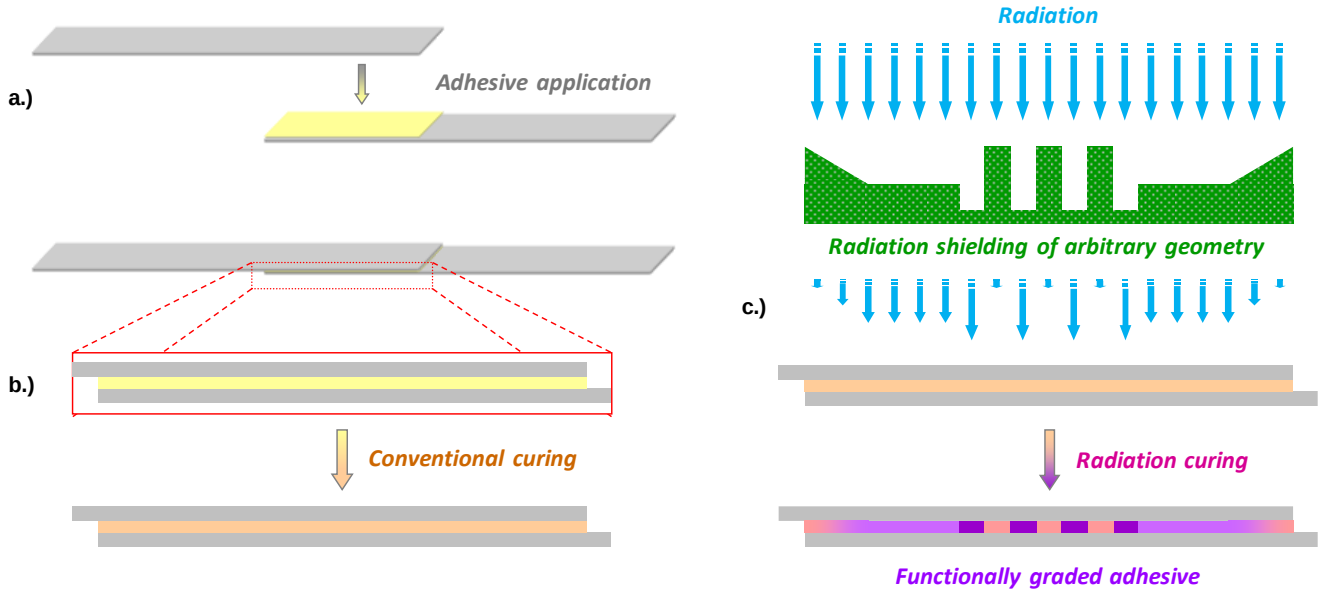

Figure 1 – The “dual cure” concept developed for the generation of stable functionally graded adhesive joints