

## Editorial corner – a personal view

### Trends – the future belongs to hybrid thermosets

*J. Karger-Kocsis\**

Institut für Verbundwerkstoffe GmbH (Institute for Composite Materials), Kaiserslautern University of Technology,  
Erwin Schrödinger Str. 58, D-67663 Kaiserslautern, Germany

The commercial success with thermoplastics is mostly due to their ‘blending’. Via ‘blending, alloying’ the beneficial properties of the related thermoplastic resins can be combined and even tailored upon request in many cases. Blending does not necessary mean melt compounding, but covers numerous other techniques, as well (e.g. ‘reactor blends’ produced by in-situ polymerization).

Interestingly, fewer efforts were dedicated to follow this concept for thermosets, except rubbers. Similar to thermoplastic systems, the ‘blending concept’ was introduced for thermosets when starting with their toughening. Nowadays, toughened thermosets, especially epoxy resins, are commercialized. Their toughener content is usually less than 10 wt.%. The vivid academic interest in the past to prepare interpenetrating network (IPN) structured systems can be considered as the beginning of thermoset ‘hybridization’. Combination of two or more resins, which crosslink separately or co crosslink with each other in various extents, means a great potential for property modification. A commercial breakthrough with this concept was already achieved with unsaturated polyester-urethane and vinylester-urethane hybrid resins.

The driving force of resin hybridization in the future is linked with the necessary use of resins made (at least partly) from renewable resources. Note that the crosslinked network of resins of natural origin (e.g. from plant oils which will come sooner or later from gene-manipulated plants) can never be so tight as that of ‘traditional’ ones derived from petrochemical resources. This is due to the fact that the molecular segments between the

crosslinking sites are much longer (and at the same time usually less reactive) than in the present systems. So, the related products are closer to rubbers than to thermosets which is well reflected by their low glass transition temperature ( $T_g$ ). Consequently, additional co reactions and/or formation of IPN or IPN-like structures are needed to push the stiffness, strength and  $T_g$  toward higher values. It can be prophesied that the polyurethane chemistry will be one of the right tools to reach this target due to its versatility. However, we are faced with severe problems when following resin hybridization routes, from which only one has to be borne in mind here. The end-users prefer to utilize 1- or (maximum) 2-component systems, which can not always fulfilled by hybrids. To develop ‘user-friendly’, robust 2-component systems is a great challenge that can likely be met by adopting suitable blocking, end capping strategies. So, there is much to do, but it is of worth, is not it?



Prof. Dr.-Ing. Dr. h.c. József Karger-Kocsis  
Editor-in-chief

\*Corresponding author, e-mail: [karger@ivw.uni-kl.de](mailto:karger@ivw.uni-kl.de)  
© BME-PT and GTE