BINARY VASCULAR SYSTEM IN SELF-HEALING EPOXY MATRIX

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ABSTRACT

Lightweight, high strength, high stiffness epoxy resin usually is used as a matrix for composite materials. Embedding of self-healing function into constructions opens a way to limit an influence of operationally induced damages on the durability of the constructions.

A model budget self-healing system for brittle epoxy matrix materials based on binary healing agent (HA) consisted of the epoxy components was developed in this work. The unidirectional vascular channels were embedded within epoxy specimens of modified tapered double cantilever beam (TDCB) geometry [1-3]. Flexible Polytetrafluorethylene tubes with diameter of 0.9 mm served as molds for channels. The distance between channels was of 5mm. Epoxy resin with 20 % additives of surfactant 4-nonilfenol and amine-based hardener were the components of binary HA. The two components were injected and remain isolated and stable in two sets of independent sealed channels during 3 days until crack formation occurs during fracture test.

The evaluation of the efficiency of the binary vascular system was conducted in load – displacement tests using quasi-static loading conditions of the modified TDCB samples with the self-healing system. Modified TDCB samples had borings for crack propagation limitation. The residual stiffness of non fractured part of the samples provided crack faces closing after samples reloading for successful self-healing. Gravity and capillary forces escape the healing agents from channels into the crack plane, where they reacted and effectively bonded the crack faces. The tests after accelerated curing during 24 h at 50 °C demonstrated healing efficiency (72 ± 18) % for the first healing cycle. The vascular system of repeatedly cracked samples was replenished with HA. After slight face separation samples were subjected once again healing cycle. Healing efficiency achieved (98 ± 35) %.

The experimental results show possibility for usual commercial epoxy composites' development with economy self-healing function using the same epoxy materials as HA without any premixing.

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