9 Summary

Due to the increased demand for aesthetic restorative materials and their continual development, the great variety of direct, plastic, tooth-colored restorative materials has increased permanently over the past years. To enlarge the spectrum of treatment hybrid composites with changed viscosity have been developed. The aim of this study is to classify flowable and condensable composite materials in comparison to common hybrid composites.

Herculite XRV (Kerr- Sybron GmbH, Karlsruhe, Deutschland), Tetric Ceram (Ivoclar Vivadent, Ellwangen, Deutschland), Tetric Flow (Ivoclar Vivadent GmbH, Ellwangen, Deutschland), Tetric Ceram HB (Ivoclar Vivadent, Ellwangen, Deutschland), Solitaire 2 (Heraeus Kulzer GmbH, Hanau, Deutschland) and SureFil (Dentsply DeTrey GmbH, Konstanz, Deutschland) were tested with regards to bending strength, modulus of elasticity, water absorption, solubility, radiopacity, depth of cure, hardness profile and its ability to be polished. Artificial aging was simulated by a 30-day water storage followed by 5000 cycles thermocycling between +5 and +55 °C to test the bending strength, the elastic modulus and their polishable qualities .

The Three-Point-Bending-Test determined the bending strength and the modulus of elasticity. Two measuring lines with 10 test bodies each were carried out. The first measuring line was stored in water for 24 hours at 37°C according to EN ISO 4049. The average results were: Herculite XRV (93 MPa), Tetric Flow (109 MPa), Tertic Ceram (95 MPa), Tetric Ceram HB (103 MPa), Solitaire 2 (95 MPa) and SureFil (100 MPa). The Scheffé-test did not show a significant difference between the materials ($p>0,05$). All composites comply with the standard. After a storage time of four weeks at 37°C and the following thermocycling bending strengths were shown in the second measuring line as followed: Herculite XRV (89 MPa), Tetric Flow (89 MPa), Tetric Ceram (86 MPa), Tetric Ceram HB (91 MPa), Solitaire 2 (65 MPa), SureFil (89 MPa). The average results did not differ significantly. After the artificial aging of Solitaire 2 the bending strength no longer complied with the norm for class- II-composite restorations.

The bending strengths before and after the artificial aging did not differ significantly from each other. Regarding the elastic modulus, the following results were shown after the 24-hour water storage: Herculite XRV (8268 MPa), Tetric Flow (5156 MPa), Tetric Ceram (6556 MPa), Tetric Ceram HB (10054 MPa), Solitaire 2 (6962 MPa) und SureFil (12578 MPa).After 30 days of water storage and 5000 cycles thermocycles between +5 and +55 °C the following results were determined: Herculite XRV (8066 MPa), Tetric Flow (4481 MPa), Tetric Ceram (7976 MPa), Tetric Ceram HB (9368MPa), Solitaire 2 (6058 MPa) und SureFil (11945 MPa).
No significant difference could be determined between the elastic modulus of each composite material before and after the artificial aging.

The water absorption was calculated after 7 days of water storage according to EN ISO 4049. For every composite ten test bodies were made. The water absorption of the tested composite materials with Herculite XRV were 13,48 µg/mm^3, Tetric Flow (18,54 µg/mm^3), Tetric Ceram (12,43 µg/mm^3), Tetric Ceram HB (8,5 µg/mm^3), Solitaire 2 (17,81 µg/mm^3), SureFil (9,34 µg/mm^3). All materials were way below the limit required by the norm of 40 µg/mm^3 water absorption.

The solubility was tested after the test bodies that had been stored in water had completely dried off. The following results could be determined for their solubility: Herculite XRV (2,81 µg/mm^3), Tetric Flow (0,55 µg/mm^3), Tetric Ceram (0,58 µg/mm^3), Tetric Ceram HB (–0,41 µg/mm^3), Solitaire 2 (3,22 µg/mm^3), SureFil (–0,04 µg/mm^3). All average results were below the limits for solubility of 7,5 µg/mm^3 required by the norm.

The x-ray opacity was tested by comparing with a 99.5% aluminium- step- wedge according to EN ISO 4049. The highest aluminum equivalence results were determined for Tetric Ceram (400 %) followed by Tetric Ceram HB (350 %). The radiopacity for Solitaire 2 (200%) still complies with the norm, however it is too low for clinical recommendation.

The depth of cure was determined by the one-sided polymerization of a plastic cylinder. Five samples of each were made. The depth of cure for Herculite was 3,6 mm, for Tetric Flow 3,8 mm, Tetric Ceram (3,9 mm), Tetric Ceram HB (3 mm), Solitaire 2 (3,6 mm) and for SureFil

was 4,6 mm. All composite materials complied with the norm which required at least a polymerization of 1.5 mm.

The Vickes hardness was tested on the surface and the bottom of a 2 mm thick test body that had been shined on from one side. Five samples were made. On the surface the following degrees in hardness were determined: Herculite XRV (52 MPa), Tetric Flow (33 MPa), Tetric Ceram (49 MPa), Tetric Ceram HB (68 MPa), Solitaire2 (54 MPa) and SureFil (77 MPa). A drop of hardness in 2 mm depth was shown in: Herculite XRV (59,6 %), Tetric Flow (78,8 %), Tetric Ceram (81,6 %), Tetric Ceram HB (63,2 %), Solitaire 2 (56 %) and SureFil (80,5 %).

Polishing was tested by a perthometer on one hand and visual judgment with SEM on the other hand. The composite materials showed the following arithmetic average roughness: Herculite XRV (64 nm), Tetric Flow (46 nm), Tetric Ceram (46 nm), Tetric Ceram HB (71 nm), Solitaire 2 (83 nm) and SureFil (76 nm). After the artificial aging roughness results were: Herculite XRV (66 nm), Tetric Flow (41 nm), Tetric Ceram (51 nm), Tetric Ceram HB (67 nm), Solitaire 2 (66 nm) and SureFil (100 nm). All six tested hybrid composites showed good polishability that endured even after artificial aging.

Regarding their material-specific characteristics, flowables and condensables composites proved to be an enrichment to modern adhesive filling treatments and conform to the standards of normal viscous tried and tested hybrid composites.