Supplementary materials

Table S1. List of abbreviations and symbols in this work (except physical units).

Properties	
z, z_c, z_{mn}, z_m	– property without specification—generally, for composite materials, porous and non-porous matrix
E, E_m, E_{mn}, E_c	– elastic modulus—generally, for non-porous matrix, porous matrix, composite
σ_{Fmax}, $\sigma_{m,Fmax}$, $\sigma_{c,Fmax}$	– ultimate strength—generally, for non-porous matrix, composite
ε_{Fmax}, $\varepsilon_{m,Fmax}$, $\varepsilon_{c,Fmax}$	– ultimate strain—generally, for non-porous matrix, composite
A_{Fmax}, $A_{m,Fmax}$, $A_{c,Fmax}$	– energy need for ultimate strength achievement—generally, for non-porous matrix, composite
$S_{m,rel}$	– relative area lying below tensile curve up to ultimate strength achievement in the case of non-porous matrix (obtained by calculation, measured is not available)
Structural parameters	
n, n_m	– porosity (generally), matrix porosity
n_{max}, n_{min}	– maximal and minimal porosity
ρ, $\rho_{t,}$, ρ_{it}	– density (generally), theoretical density of sample (porosity neglecting) resp. of its component
v_{it}	– volume fraction of ith component in material
v_m, $v_{m(t)}$	– matrix volume fraction—real and with porosity neglecting
n_p	– interspace filling
v_f, $v_{f(t)}$	– volume fractions of filler—real and with porosity neglecting
$1-v_f$	– interspace volume
$1-n$	– solid rate of material
n_{pf}	– matrix rate in solid rate of material = matrix volume fraction if the porosity is neglected
m, wt.%, V, vol.%	– mass, weight percent, volume, volume percent
Remaining parameters	
b, *c*	– exponents ensuring the best fitting of spatial exponential function serving for filled porous composites mechanical behavior description (different properties = different *b, c* values)
d, e, f, g	– parameters arising through *b* and *c* fitting by matrix properties
δ	– OH/NCO rate in polyurethane matrix before curing, substituting the matrix polarity and adhesion of matrix for other material components
Chemical components designations	
P	– pre-polymer Unixin PU4223 based on MDI
MDI	– methylene-di-phenyl-di-isocyanate
W, G, CO	– curing agents—water, glycerol, castor oil
LO, Si, Ca, Fe	– matrix modifiers—linseed oil, quartz, calcite, iron
R_0, R_1, R_2	– rubbery filler fractions
DBTL	– di-butyl-tin-di-laureate

Table S2. Member meaning and mean of their obtaining for totally all equations contributing to elastic modulus calculation from the general beginning (getting structural parameters) to the end (porous matrix including). The other properties are not mentioned because of the same calculation method.

Parameter	Significance in Equations (1), (5), (6), (8-9)	Derived from…
n_p	interspace filling	calculated by Equation (5)
n	sample porosity	calculated by Equation (1)
$v_{m(t)}$	matrix volume fraction in hypothetical nonporous material	known (adjusted)
$1\text{-}v_f$	interspace volume	calculated by Equation (6)
$1\text{-}n$	solid rate of material	calculated from porosity (by Equation (1))
v_m	volume fraction of matrix	calculated by Equation (8)
n_{pf}	matrix rate in solid rate of material	calculated by Equation (9)
Parameter	**Significance in Equations (10), (12)**	**Derived from…**
E_c	*E* value of composite	measured (10,12)
E_m	*E* value for nonporous matrix	obtained by fitting in (10) and then used in (12)
v_m	volume fraction of matrix	calculated from porosity (by Equation (1)) and composition (known)
$1\text{-}v_f$	interspace volume	calculated by Equation (6)
b, c (10)	exponents	values ensuring the highest R^2
d, e (12)	*b* exponent parameters	fitting of *b* according to E_m in (12)
f, g (12)	*c* exponent parameters	fitting of *c* according to δ (12)
δ (12)	OH/NCO ratio in uncured matrix	known (adjusted)
Parameter	**Significance in Equations (11), (15)**	**Derived from…**
n_p*	interspace filling	calculated by Equation (5)
d, e (15)	*b* exponent parameters	*b* fitting according to E_m and δ (16)
the other members	same meaning as in Equations (10,12)	corresponding to Equations (10,12)
Parameter	**Significance in Equations (21), (22)**	**Derived from…**
E_{mn}	*E* value for porous matrix	measured
E_m	*E* value for nonporous matrix	from Equations (10) or (11)
n_m	porosity of porous matrix	measured
b	exponent	calculated by Equation (21)
d, e (22)	*b* exponent parameters	*b* fitting according to E_m in (22)

* instead of $1\text{-} v_f$ in (10,12)

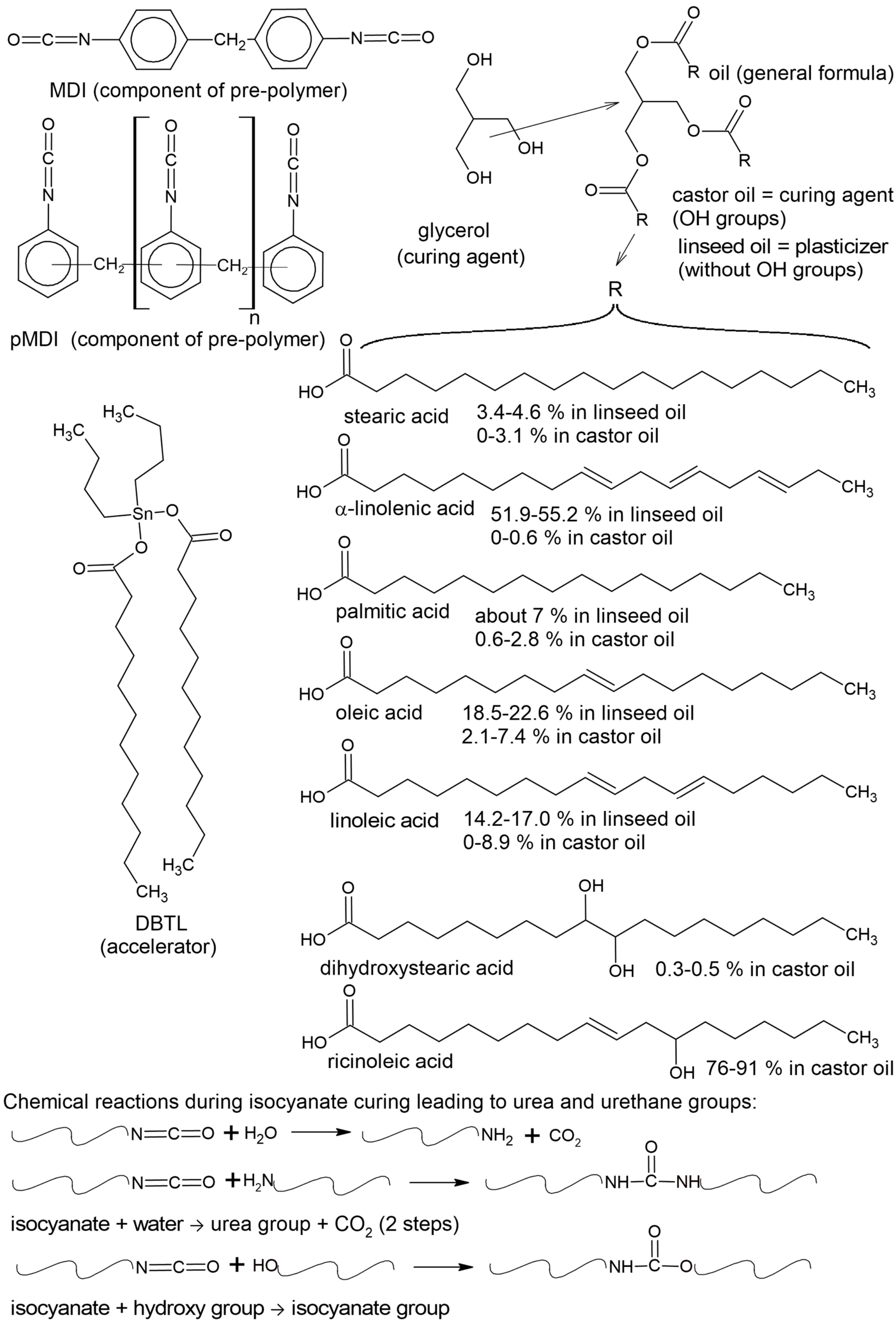

Figure S1. Polyurethane chemistry related to curing of matrices. The scheme contains the used components formulas [39,40] (approximate in case of pre-polymer containing 10-30 wt% MDI—methylene-di-phenyl-di-isocyanate) and basic chemical reactions leading to polyurethanes (polyureas).

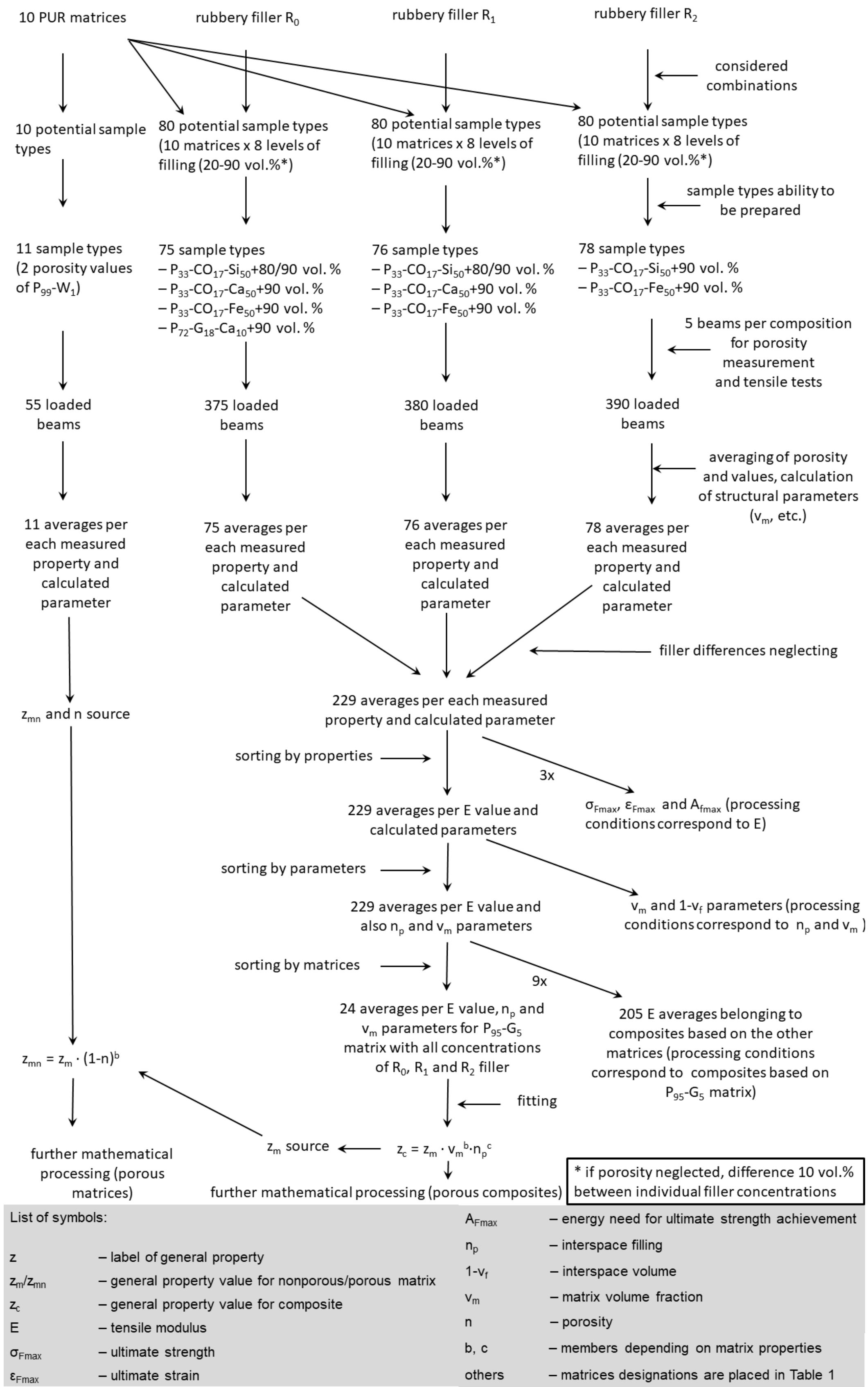

Figure S2. The schematic overview of preparation and testing of samples and following data and style of their utilization in further mathematical processing.

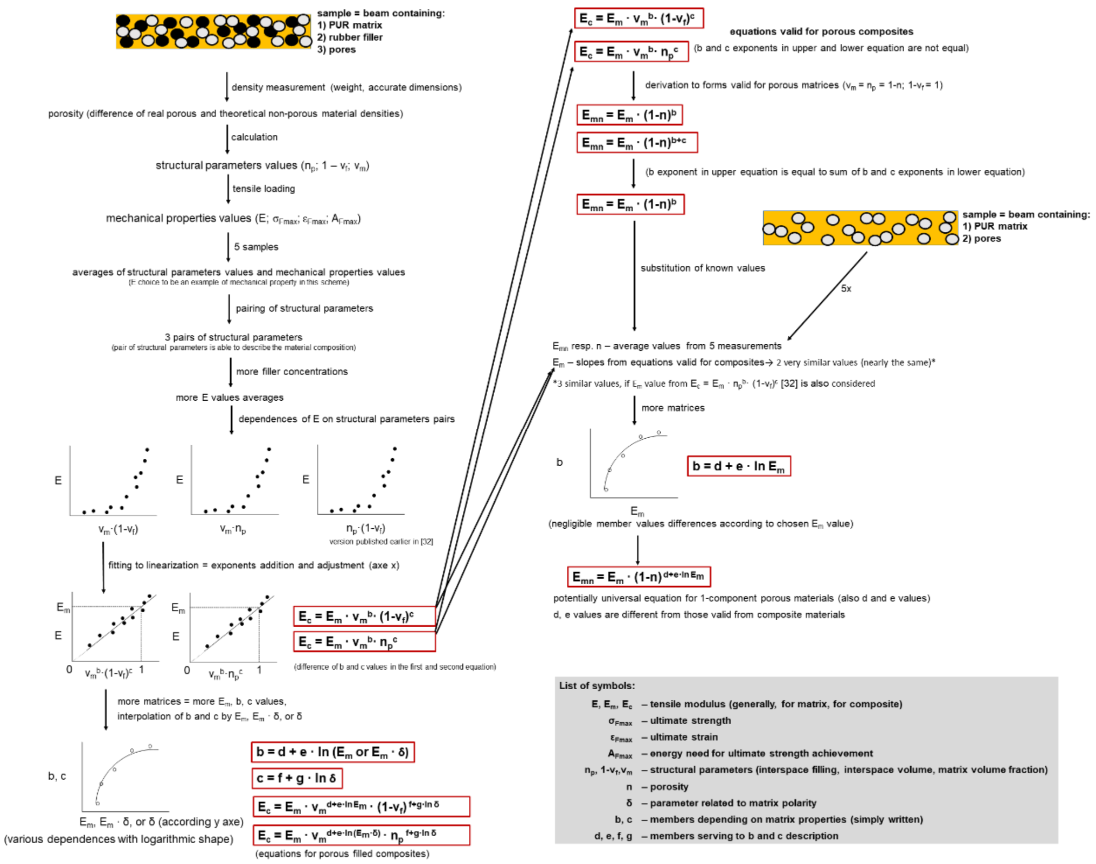

Figure S3. Data obtaining and processing—from beams to final equations.

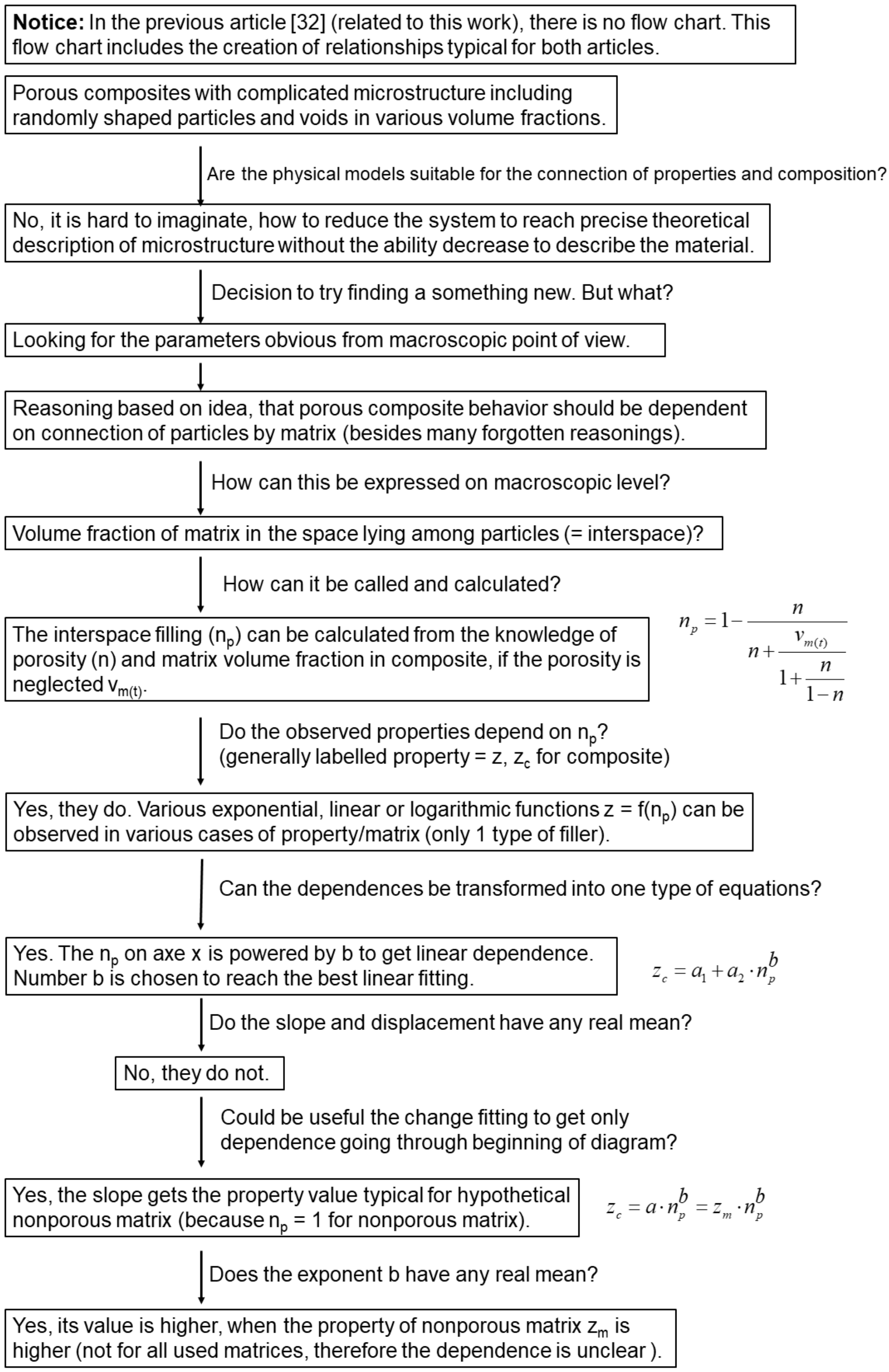

Figure S4. Flow chart including the thinking process through the whole research—1st part.

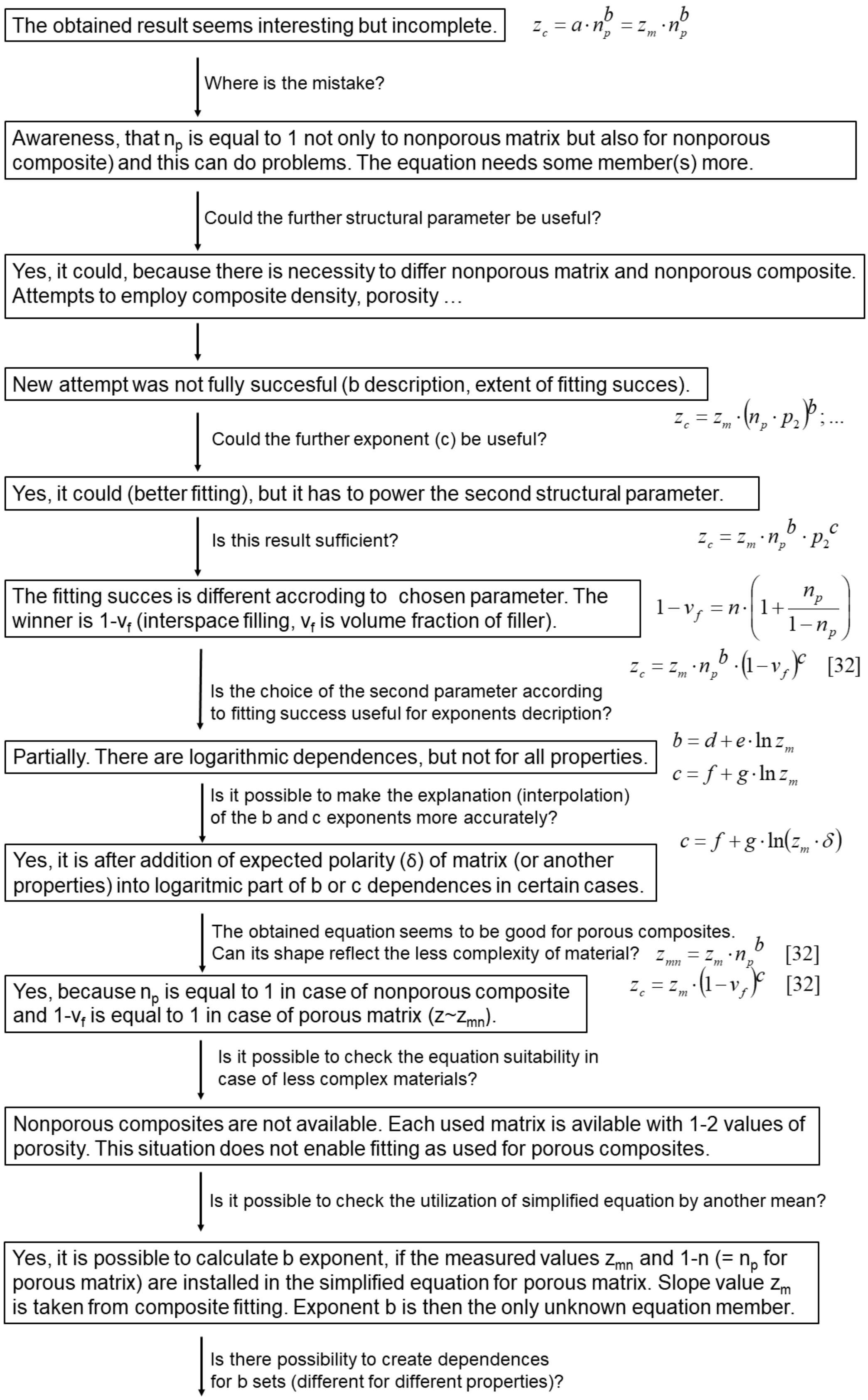

Figure S5. Flow chart including the thinking process through the whole research—2nd part.

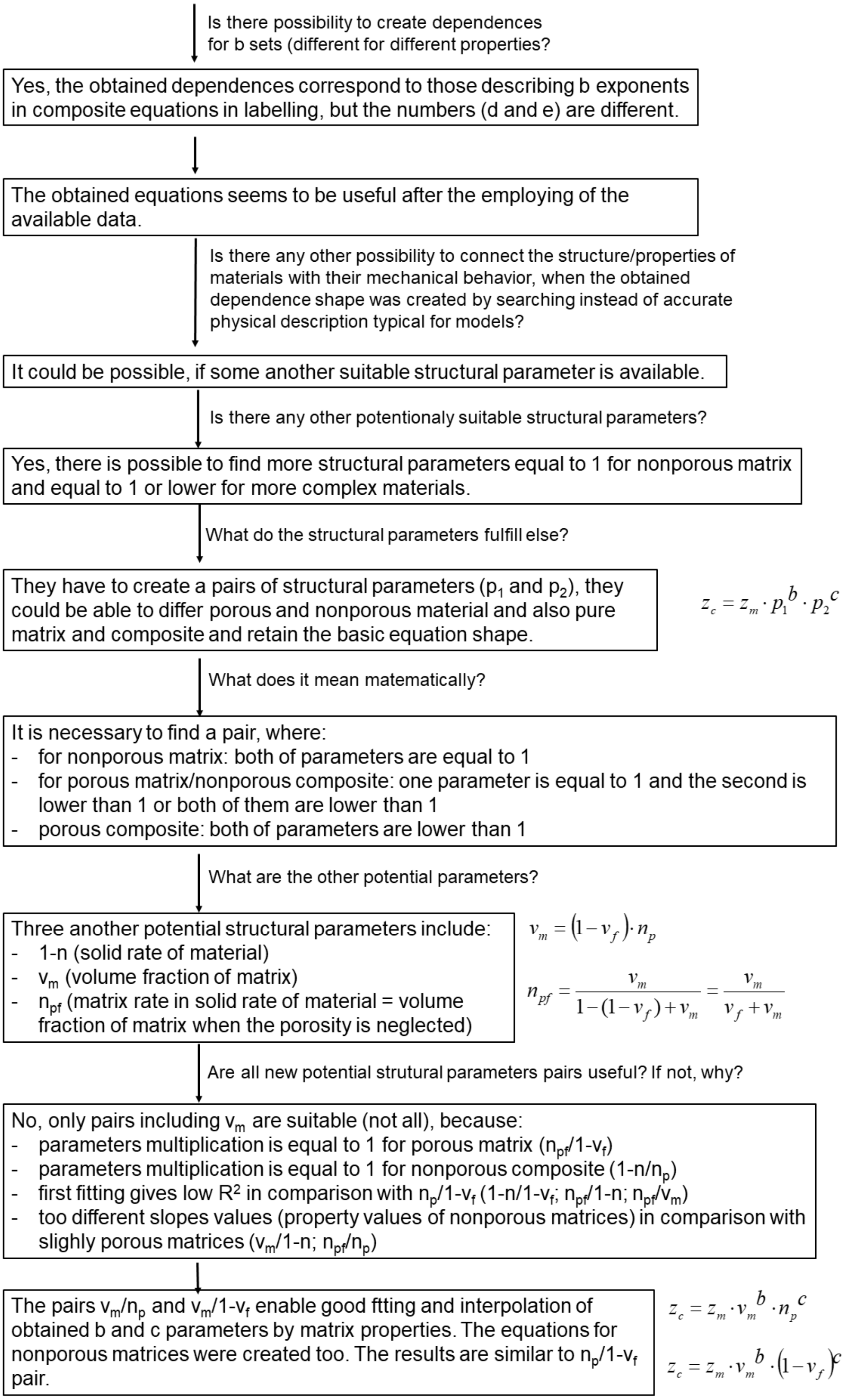

Figure S6. Flow chart including the thinking process through the whole research—3rd part. It is necessary to add that Equation (3) (valid for 1-component materials in the form telling that exponents are number, not function) is mathematically at the beginning, but mentally is in the end. The results occurring in the literature belonging to 1-component materials were found after the research to add a suitable background. The results not including models/simulations for porous composites were looked for at the beginning of the research without success.