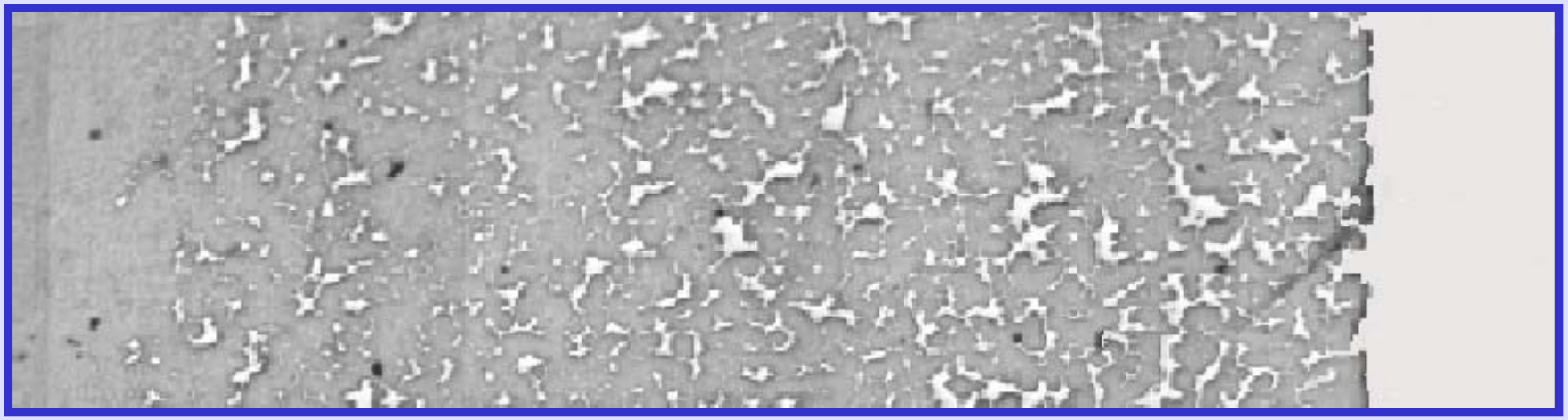

Microstructure and Thermo-mechanical Properties of Self Formed Cu-W Graded Materials

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Topics of the presentation

- ***Experimental procedure - production of Cu-W FGM's***

Introduction - Segregation

- ***Results***

-Time evolution of segregation

-Microstructure of infiltrated Cu-W FGM and a corresponding concentration profiles

-Characteristic of Cu-W FGM

- Young's modulus (pulse echo ultrasonic test)
- Electrical Properties (4-probe technique)

Temperature dependence of electrical resistivity

Summary

Experimental procedure – *production of Cu-W PGM*

ungsten powder
-5μmAPS, 45-75μm)

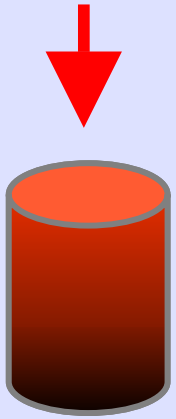
gglomeration with polymer (polyvinylbutyral)
-5/60μm, 200/250μm)

egregation
= 600Hz, a = 6g, τ = (1-2h), Ha = 9.73g/m^3)

hermal treatment
100°C,10 h, N_2)-binder burn out
450°C,3h, 10%H_2+90%N_2)-sintering of W body

nfiltration of molten Cu
250°C,2h, 90%N_2+10%H_2)

Melting Cu

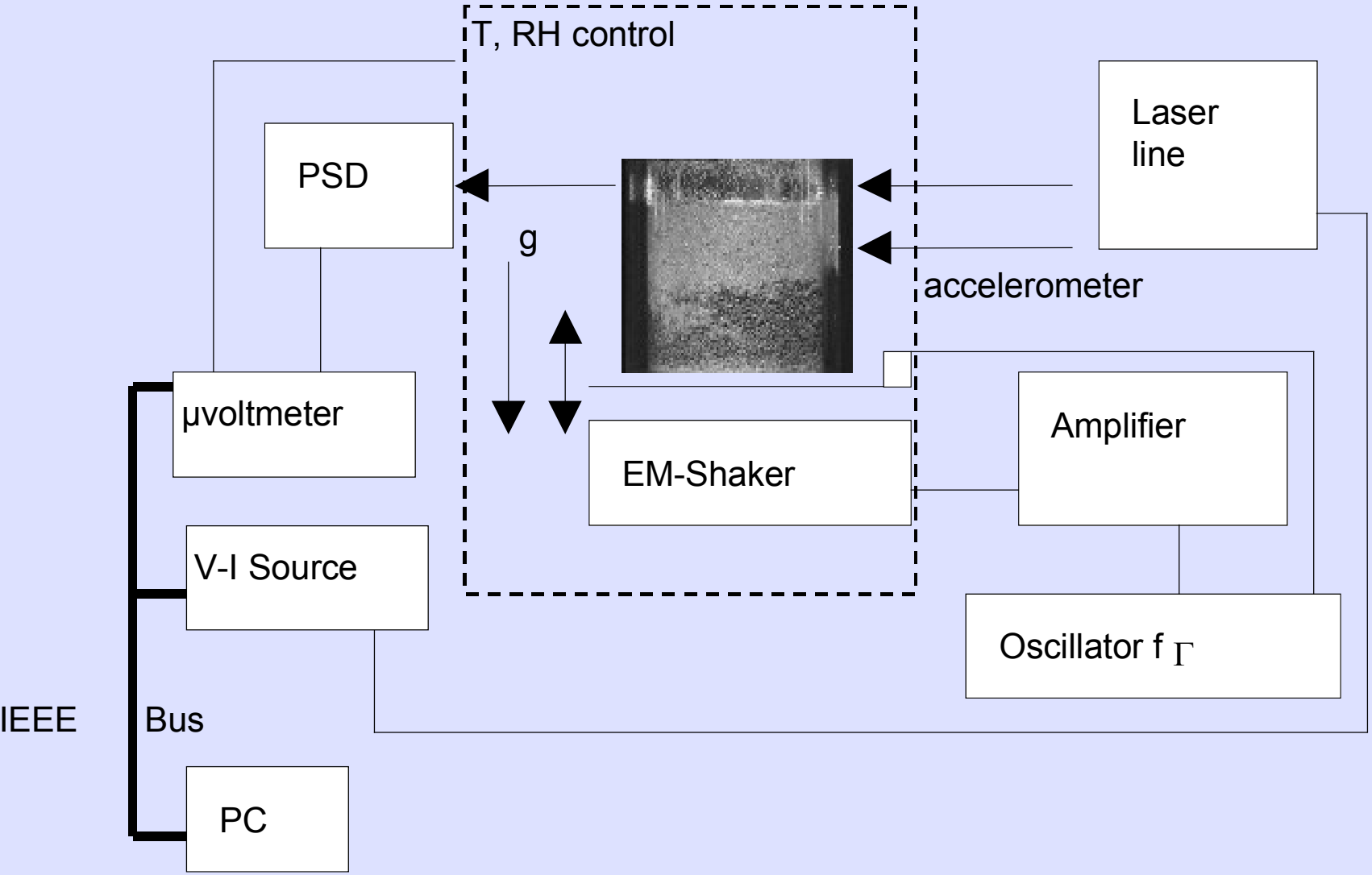


W-porous skeleton

with gradient of poro

W-Cu infiltrated

Experimental Set up



A. Start position: smaller agglomerates are in the higher gravitational position
B. Percolation of smaller agglomerates
C. Rearrangement of the bigger agglomerates due to the movement of the smaller ones.
D. Final stage corresponds to the partial or total segregation.

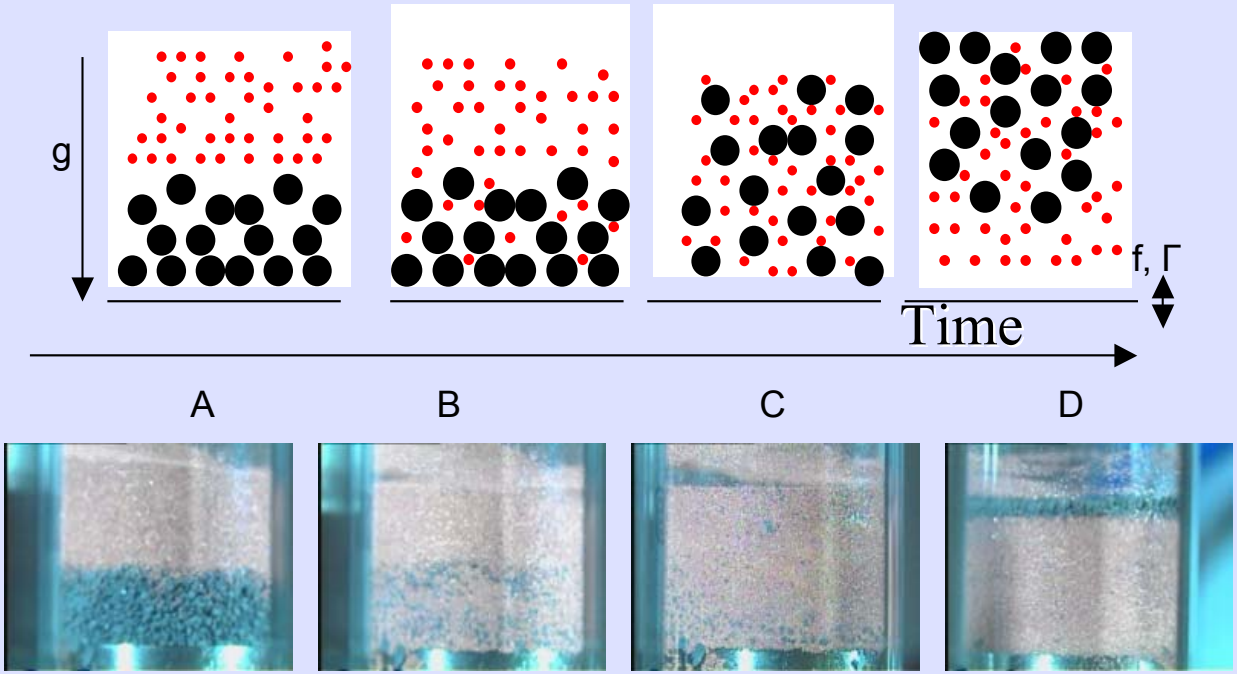
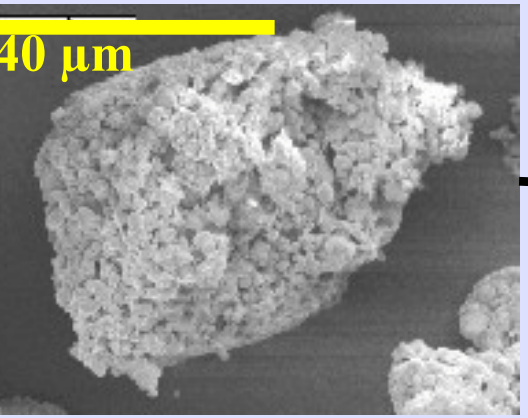
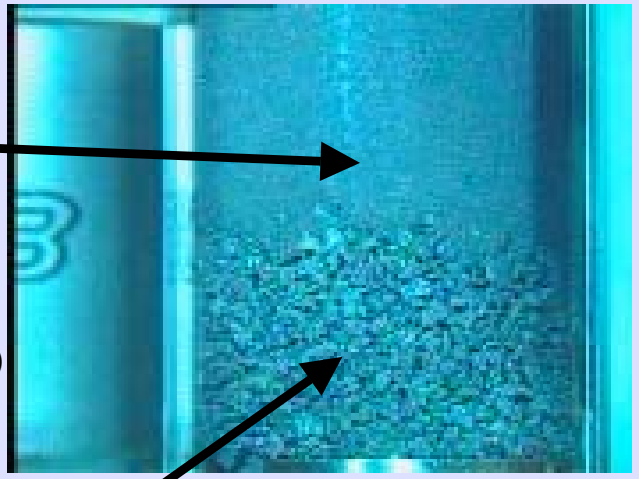
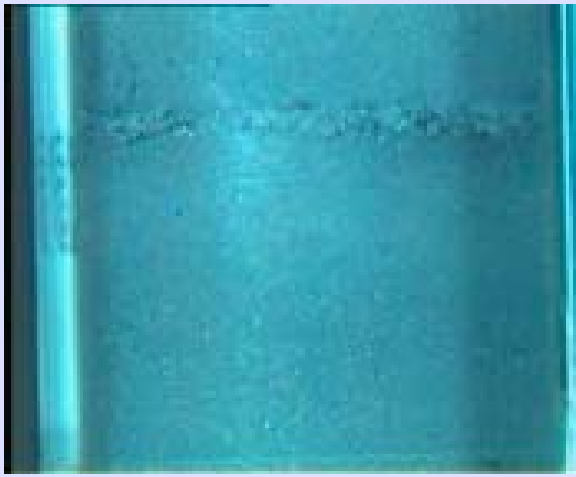


Figure 2: Time evolution of a vibrated GM-bed is shown in four times: (A) initial position, (B) percolation, (C) intermediate stage, (D) graded packing or complete segregation. The photographs are shown a process of two hours for the system W-Cu at 600 Hz and 6 g (GS regime) [Fi03b].

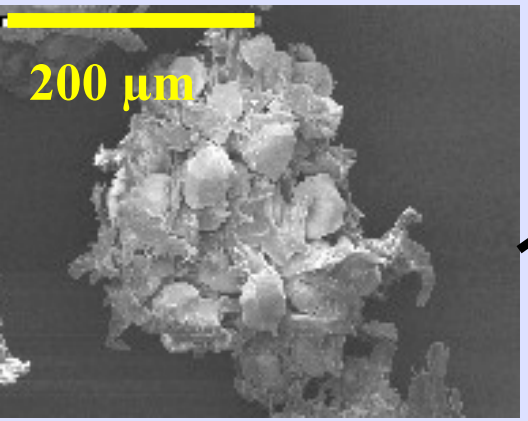


(a)





Initial position Final position

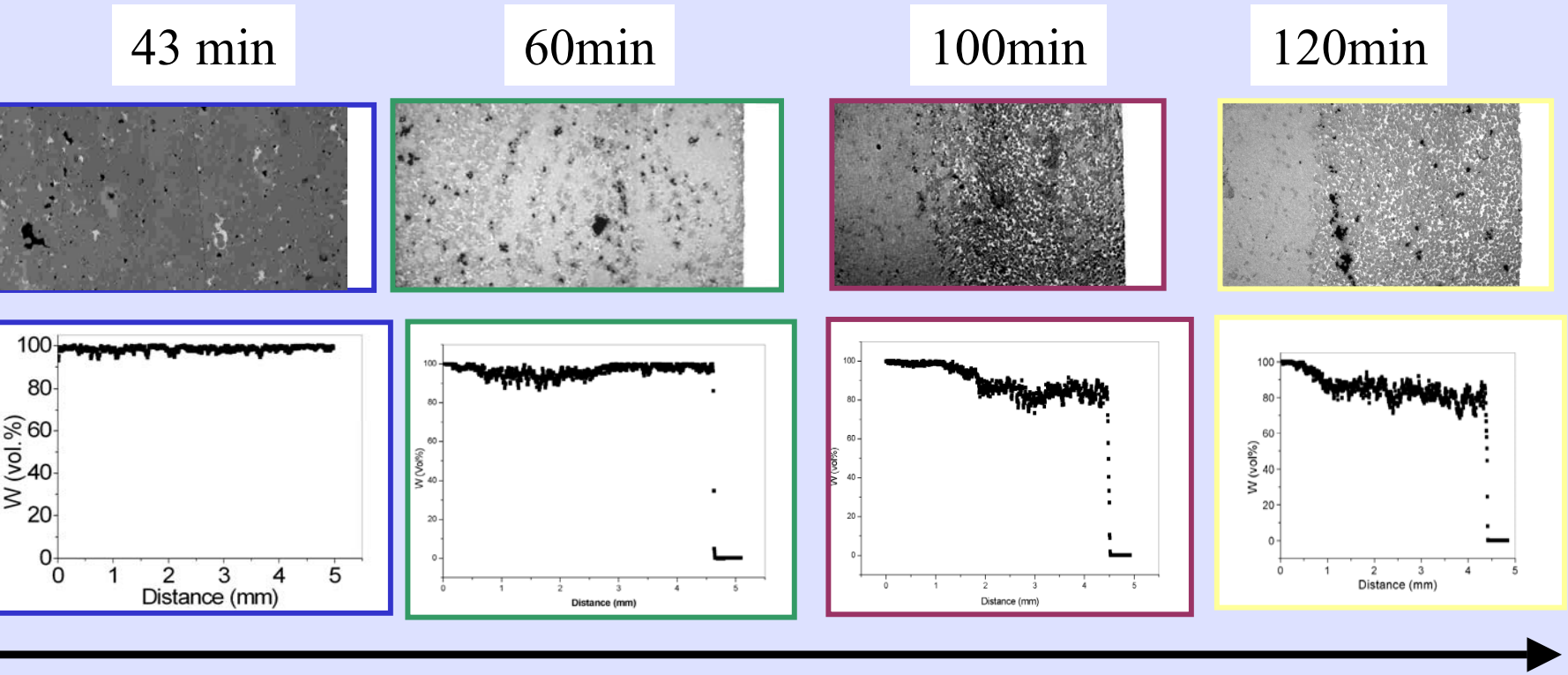


(b)

SEM micrographs of W agglomerates:

size 45-60mm (1-5mm) **(a)**, and 200-250mm (45-75mm) **(b)**.

Microstructure and Concentration Profiles vs Vibration duration



Distance (mm)

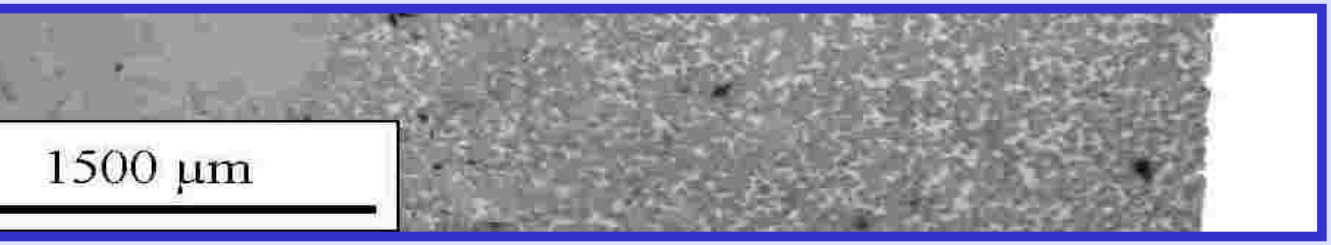
W skeleton sintered at 1450°C

MS: 1) skeleton of smaller(percolation)

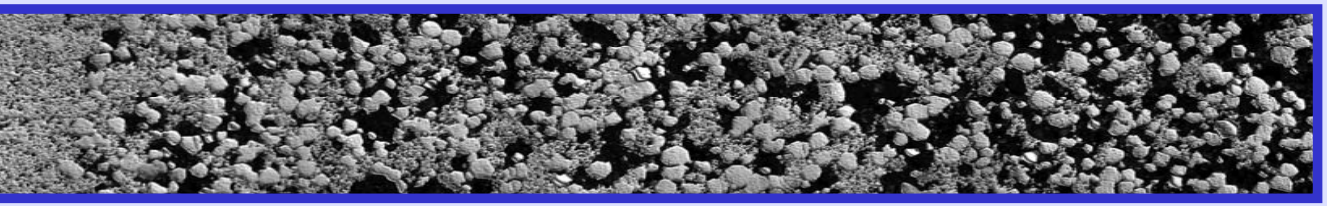
2) skeleton of larger agglomerates (diffusion stage)

3) graded type (partial segregation)

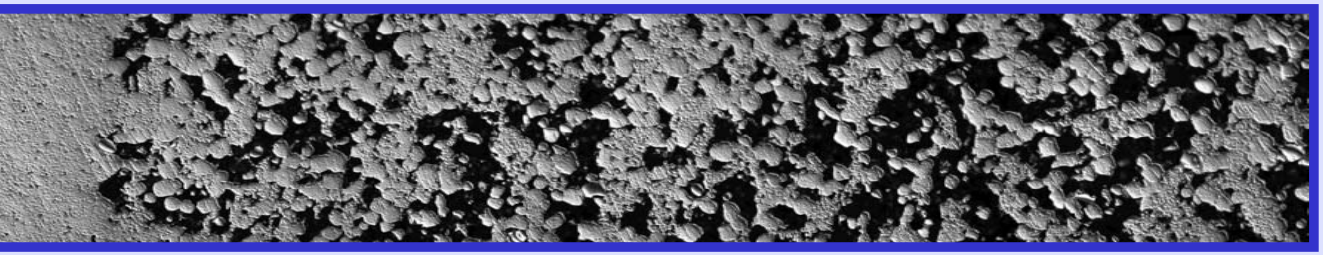
Development of "W Graded" Preform with Sintering Conditio



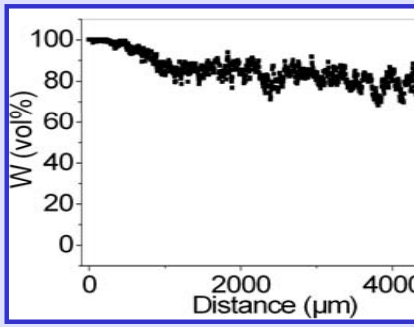
1450°C, 3h

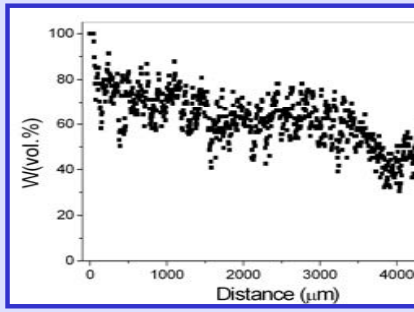


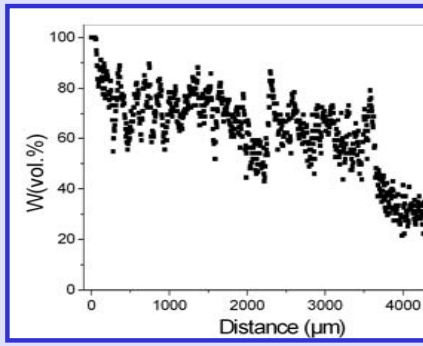
1800°C, 1h



1800°C, 3h







Porosity redistribution: Intraagglomerate porosity ↘

Interagglomerate porosity ↗

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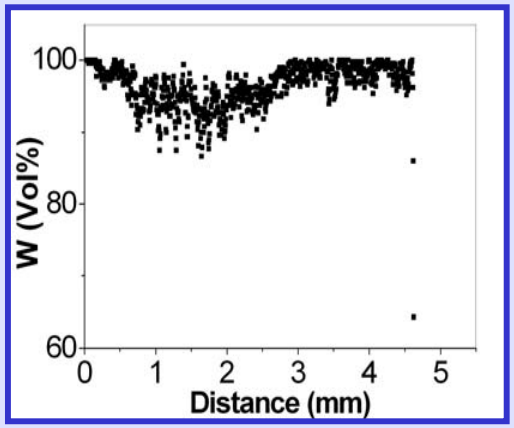
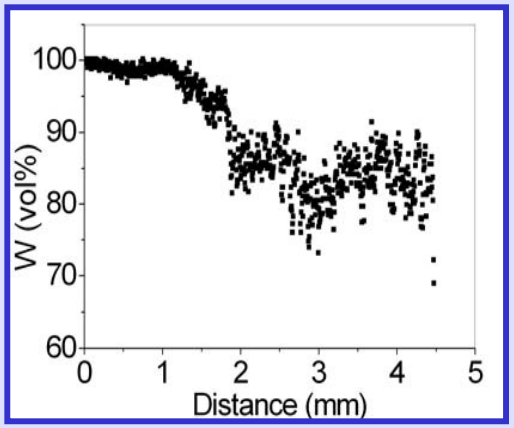
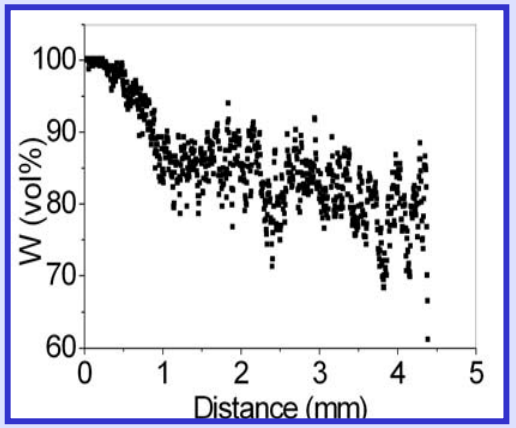
Position dependant Young's modulus



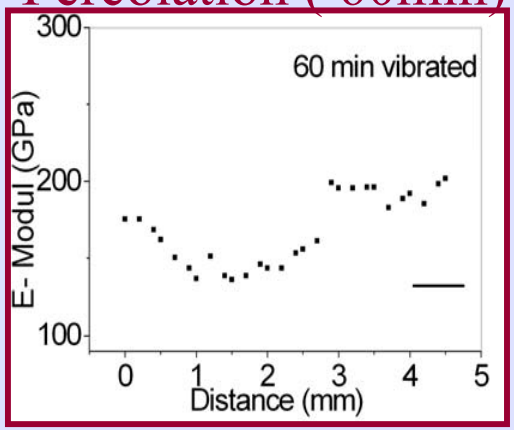


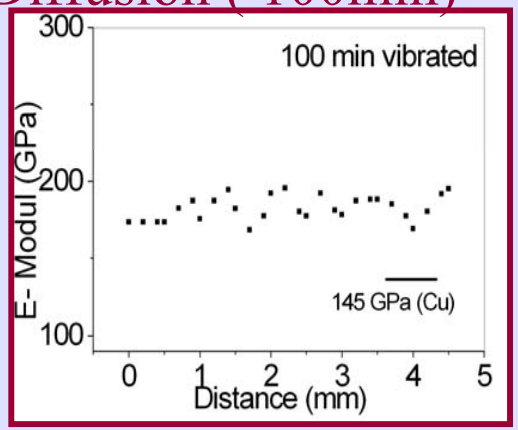


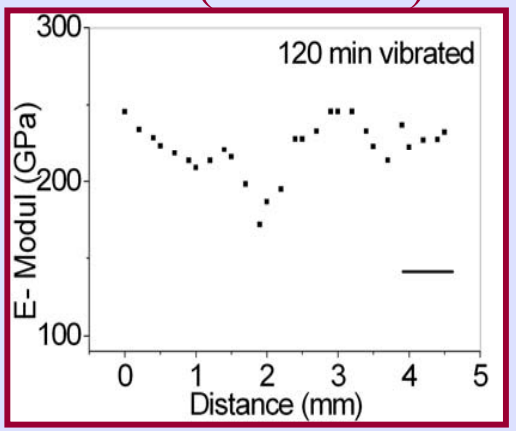
Percolation (60min)

Diffusion (100min)

Graded (120min)







W skeleton sintered at 1450°C
-analogue to concentration profile

Young's modulus

bration time (min)	Density % ρt	Cu wt l%	Contiguity%	E-modulus (1450°C)	E-modulus (1800°C
43	50,0			136	
60	57,3	37,2	27,2	175	241,46
100	58,3	35,2	32,1	172	257,27
120	59,3	32,26	36,5	229	284,5

sensitive to MS (porosity, Cu content, W-W contiguity)

graded sample: highest E-modulus (highest W-W contiguity; owest Cu content)

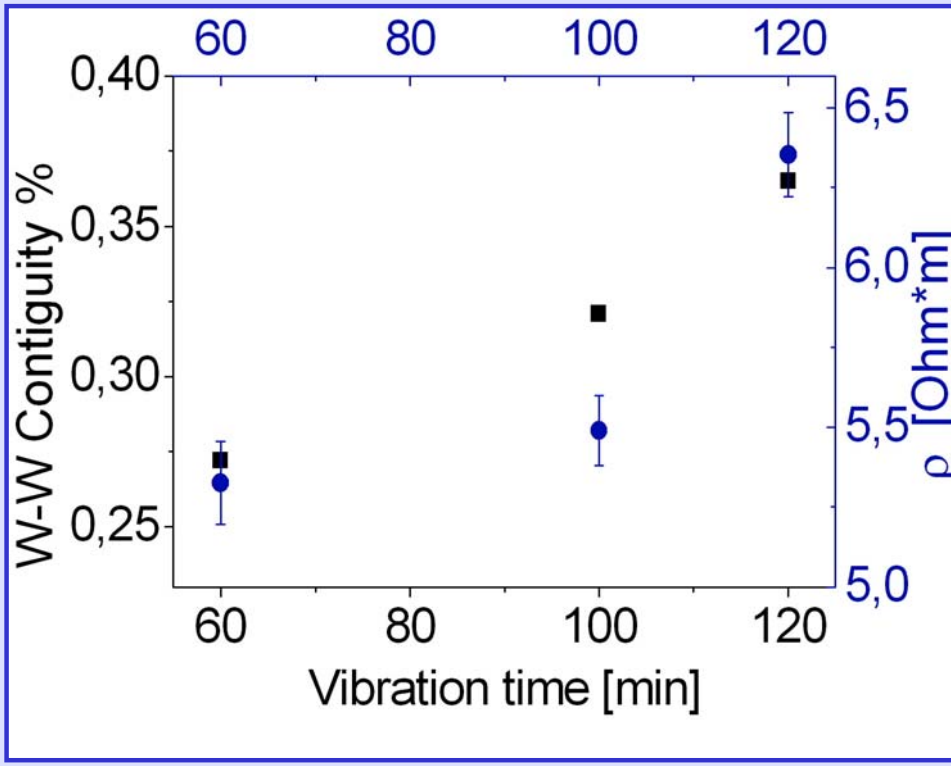
E- modulus increase with sintering T(stronger W-W sinter bonds

Electrical resistivity as a Function of Vibration Duration

sistivity increase:

u wt%↓

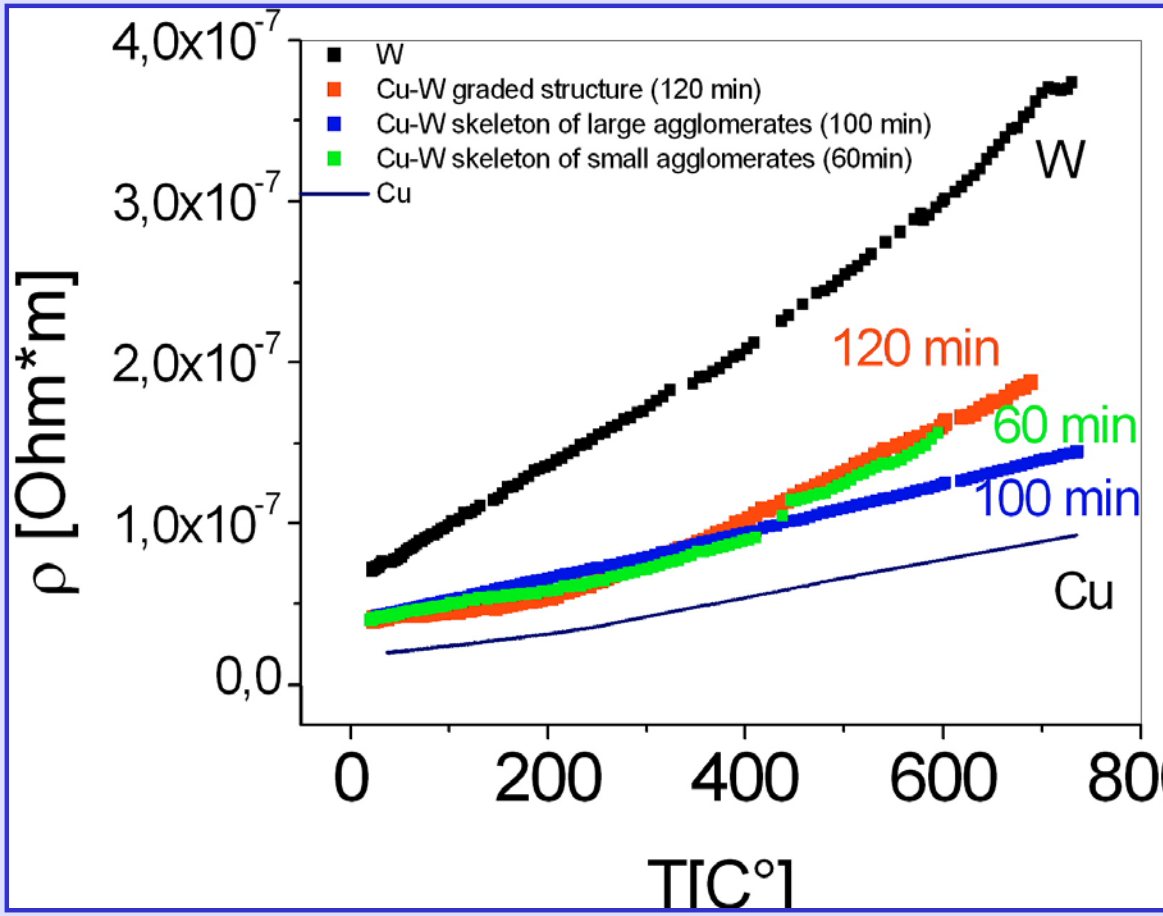
-W Contiguity↗



Vibration time (min)	Density %ρt	Cu wt.%	Contiguity%	ρ*10-8 Ω*m
60	57,3	37,2	27,2	4,635
100	58,3	35,2	32,1	4,764
120	59,4	32,3	36,5	5,647

Temperature Dependence of Electrical Resistivity

early linearly behaviour
lonon-electron interaction



Summary

ontrolled regime of geometrical segregation-GS (600Hz, 6g) was introduced
der to produce a W preform with gradient of porosity and finally Cu-W FGMs

wo types of MS: skeleton and graded are formed during vibration

ignificant increase of density in the graded structure.

raded structure has: higher E-modulus
higher electrical resistivity

Linear dependence of Electrical resisivity on Temperature
honon- electron interaction