

3D-Printed Zirconia: Can It Bond to Dentin?

Alvaro Limones,^{DDS MSD PhD,1,2} Dean Morton,¹
 Gabriela Panca,³ Pedro Molinero,^{2,3} Gunjan Srivastava,³
 Burak Yilmaz,³ Anne Peutzfeldt,³ Wei-Shao Lin,¹ & Gülce Çakmak³

¹ Indiana University, Indianapolis, IN, USA. ² Complutense University of Madrid, Madrid, Spain. ³ University of Bern, Bern, Switzerland



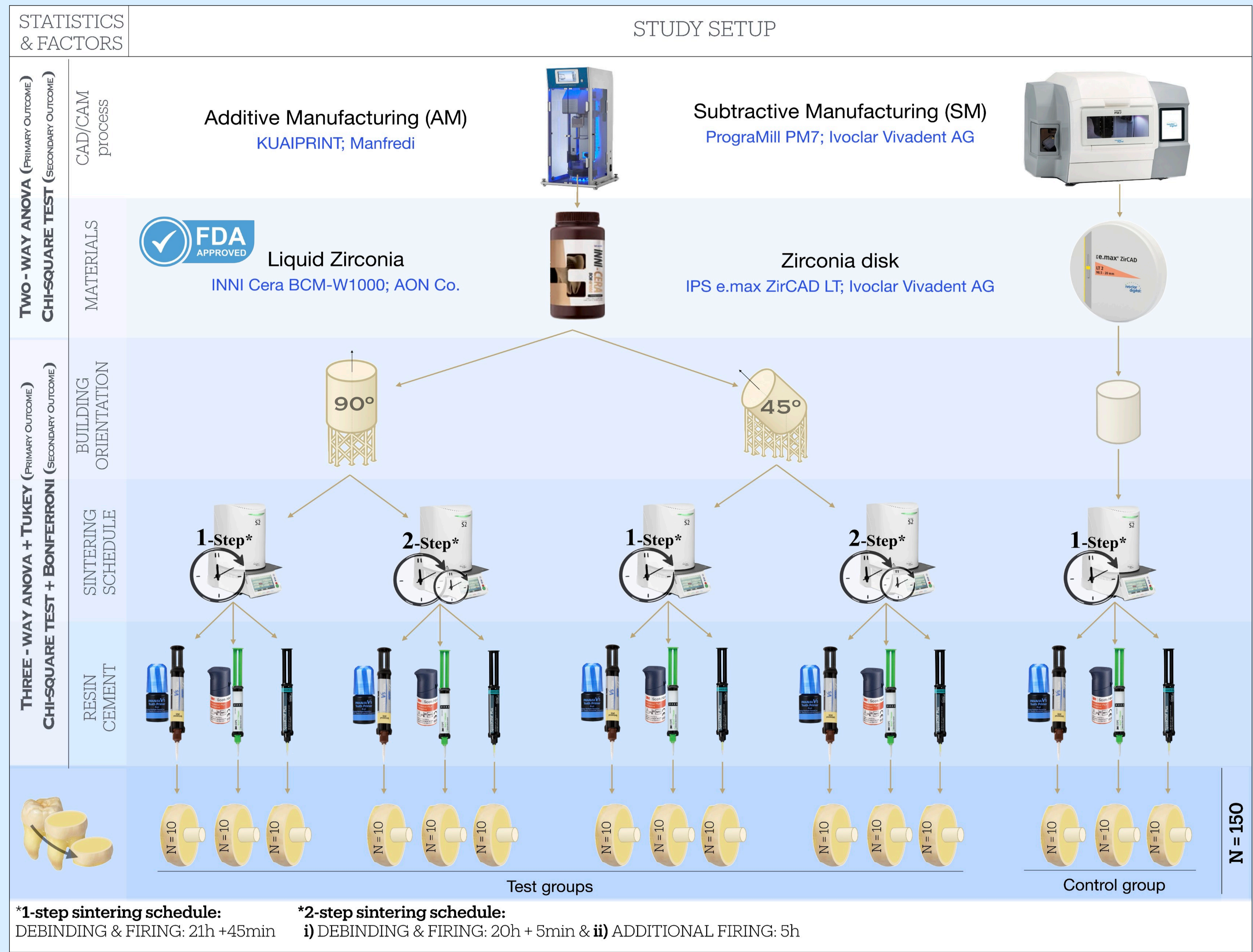
AIM
H0
MATERIAL AND METHODS

- To **compare** additively manufactured (**AM**) zirconia with subtractively manufactured (**SM**) zirconia bonded to dentin in terms of **bond strength** and **failure mode**.
- To assess the effect of (i) **build orientation**, (ii) **sintering schedule**, and (iii) **resin cement** on **AM zirconia** bonded to dentin.

H0₁: The manufacturing method AM or SM would not significantly affect the bond strength or failure mode of zirconia bonded to dentin.

H0₂: Build orientation, sintering schedule, and the resin cement would not significantly affect the bond strength or failure mode of AM zirconia bonded to dentin.

One hundred and fifty cylinder-shaped specimens (Ø2×4 mm) were fabricated from either AM or SM 3Y-TZP zirconia. AM specimens were printed using a DLP 3D printer with 50 µm layers in two build orientations (90° and 45°) and sintered using either a 1-step or 2-step schedule. SM specimens were milled and sintered conventionally. All specimens were bonded to dentin using one of three dual-cure resin cements: SpeedCEM Plus, RelyX Ultimate, or Panavia V5 (n=10 per subgroup). Dentin was prepared from extracted human molars and treated according to each cement's protocol. Zirconia surfaces were sandblasted and conditioned per manufacturer recommendations. After 24 hours, shear bond strength and failure modes were assessed. Data were analyzed using 2-way and 3-way ANOVA with Tukey post hoc tests (α = .05).

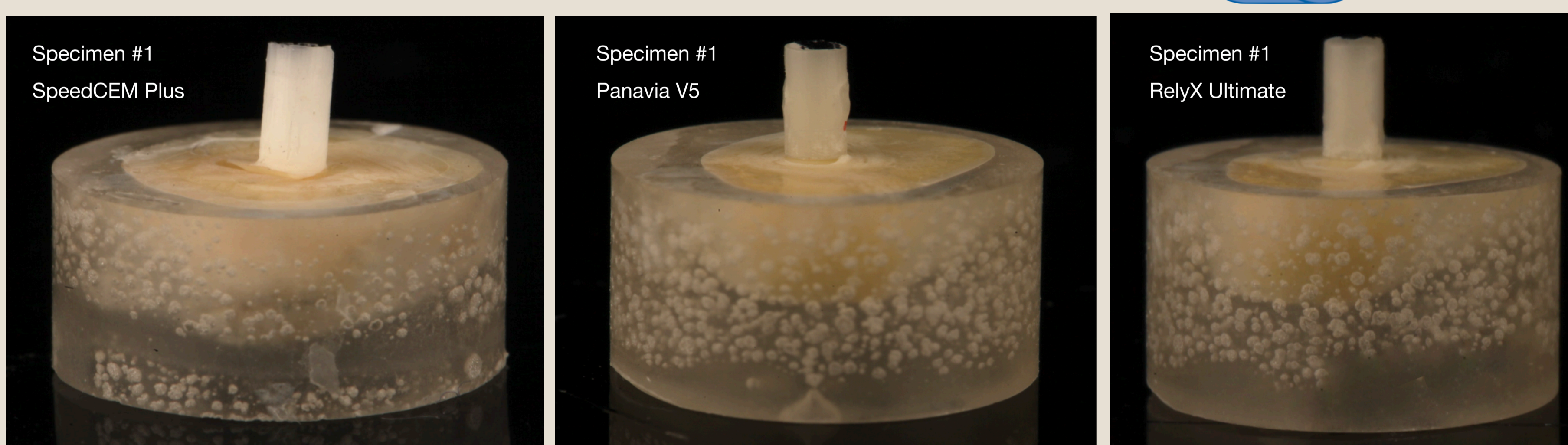
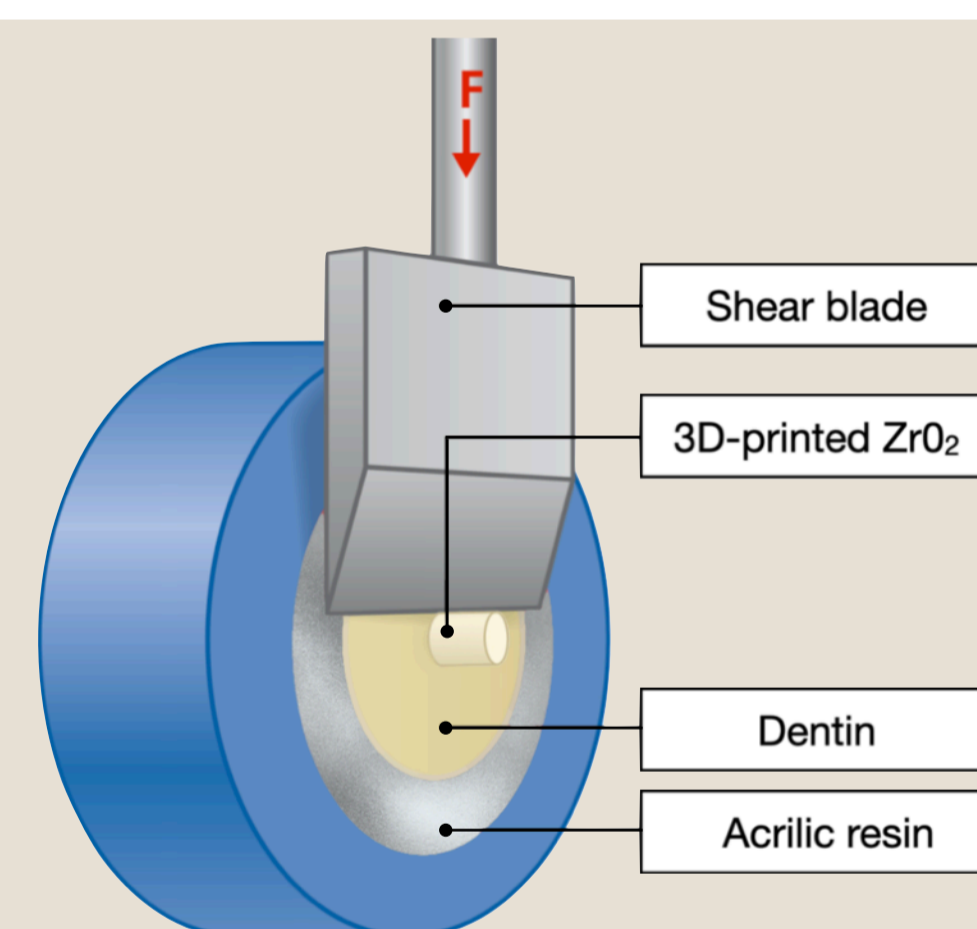


RESIN CEMENTS	MANUFACTURER (City, Country)	COMPOSITION
RelyX Ultimate + Scotchbond Universal Plus Adhesive	3M Dental, St. Paul, MN, USA	BisGMA, TEGDMA, dimethacrylates, silane-treated fillers, initiator system, an opaque shade
Panavia V5 + Clearfil Ceramic Primer Plus	Kuraray Noritake Dental Inc., Tokyo, Japan	Bis-GMA, TEGDMA, hydrophobic aromatic dimethacrylate, hydrophilic aliphatic dimethacrylate, hydrophobic phosphate monomer (MDP), silanated barium glass, silica fillers
SpeedCEM Plus	Ivoclar Vivadent AG, Schaan, Liechtenstein	UDMA, PEGDMA, dimethacrylate resins, acidic monomers, ytterbium trifluoride, initiators, stabilizers, silanated fillers

Primary Outcome

Shear Bond Strength Test (SBS)

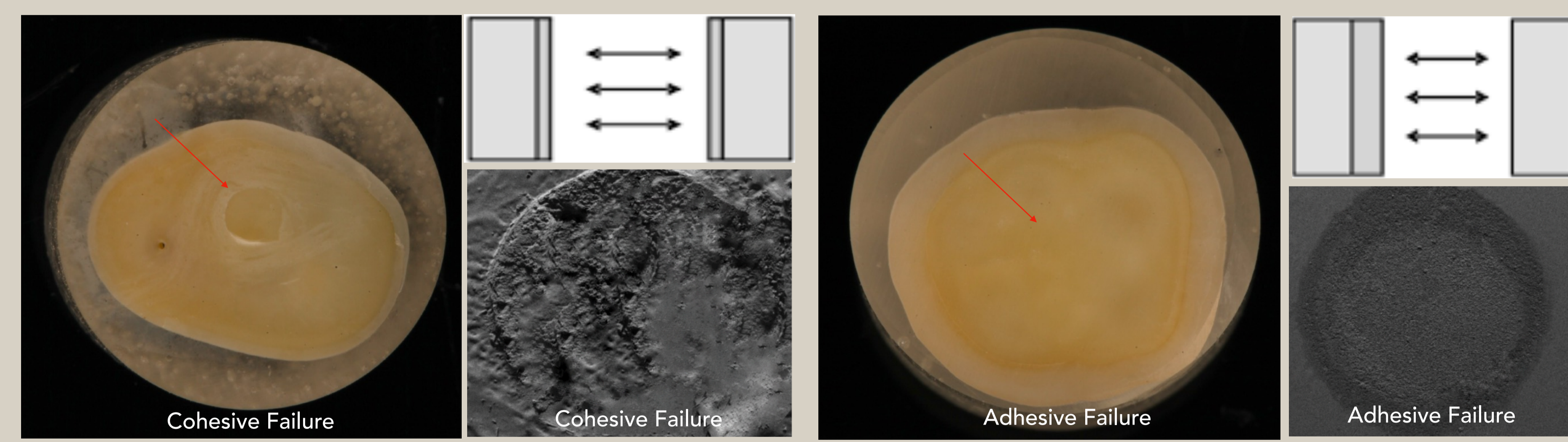
Universal testing device: crosshead speed of 1 mm/min until failure. (AGS-10 kNX; Shimadzu Co)



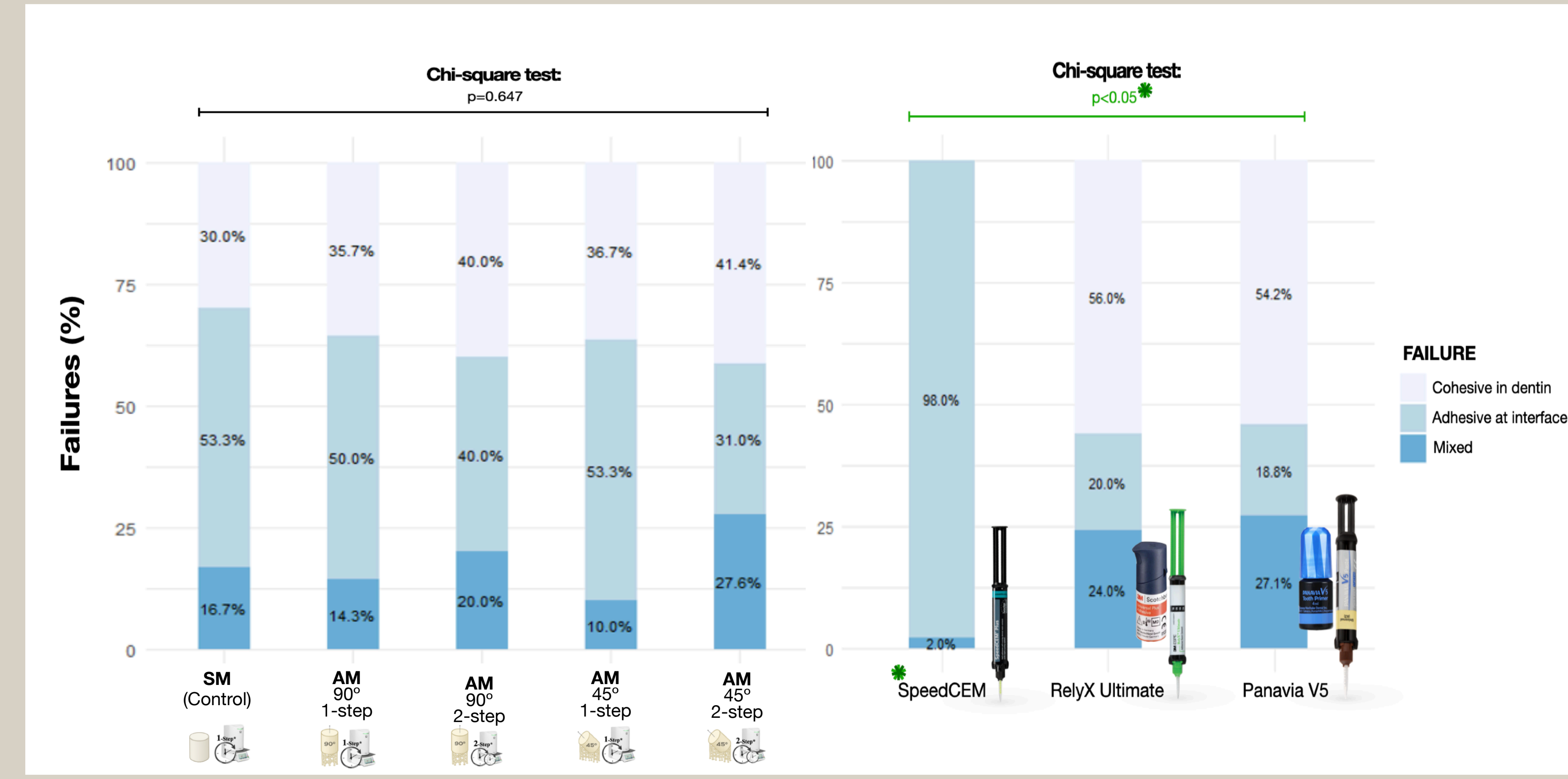
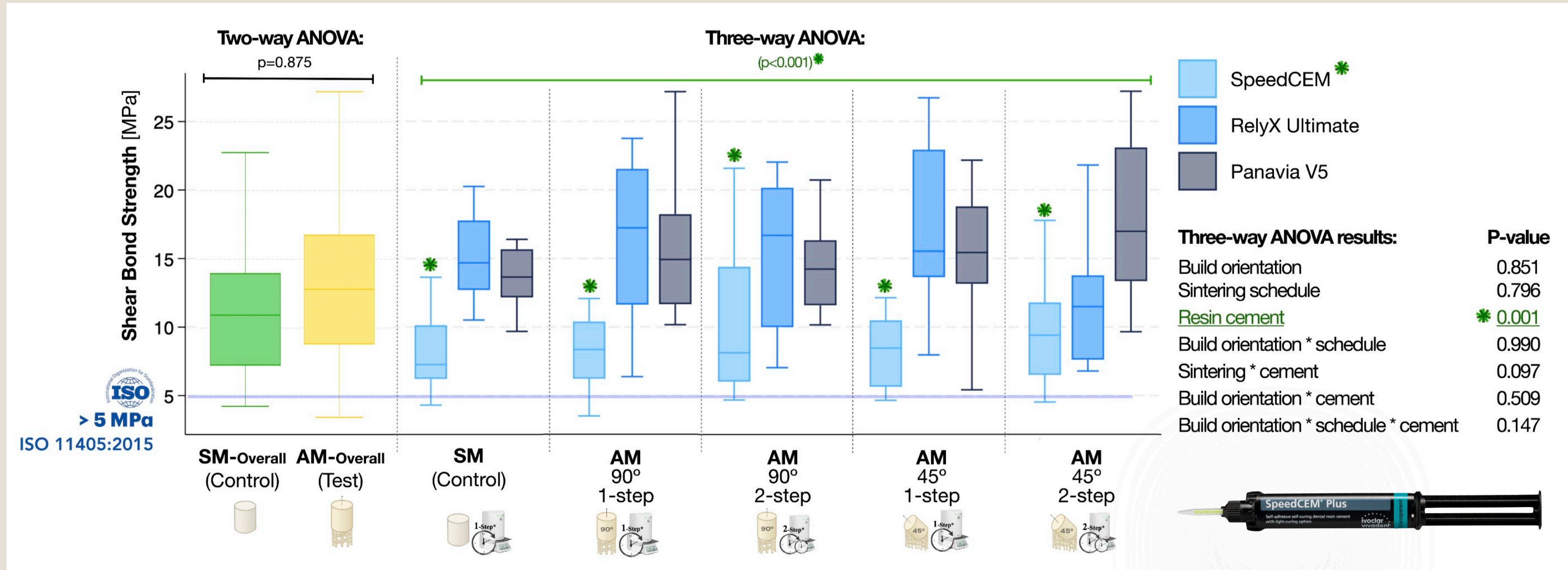
Secondary Outcome

Failure Mode Analysis

×200 magnification with a stereomicroscope (Leica SP1600; Leica Biosystems Nussloch GmbH)



RESULTS



Zirconia bonded to dentin in this study:

AM (mean): 12.72 MPa (*under review, 2025*)

SM (mean): 11.02 MPa (*under review, 2025*)

Other materials bonded to dentin in previous studies:

Resin composite (mean): 18.9 MPa (*Başol et al., 2025*)

Lithium disilicate (mean): 18.66 MPa (*Martins et al., 2022*)

CONCLUSIONS

- No significant differences** in bond strength or failure mode were observed **between AM and SM zirconia**.
- Resin cement had a significant effect on bond strength and failure mode**, whereas the **build orientation** and **sintering schedule** of AM zirconia **did not influence** bonding to dentin.

MORE INFO:

