Marie Curie Fellowships

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Influence of the polyelectrolyte and base addition sequence on the suspension properties and electrophoretic deposition behaviour of ceramic powders

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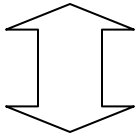
Outline

Goal: *Influence of sequence addition of BA and DC on the properties of Al_2O_3 and Ce-ZrO_2 deposits*

Suspension characterisation: **Viscosity**

BA content & sequence addition



7.4 to 74 wt% BA; 100 to 200 µl/g DC

Electrophoretic deposition: **Yield, Deformability**

Drying

Density

Suspension preparation

- Al_2O_3 (Baikowski SM8) powder
- Ce-ZrO_2 (Daiichi CEZ-12) powder
- Ethanol (to avoid gas evolution during EPD)
- Darvan C (DC) ammonium polymethacrylate

  MW= 10000 - 16000

  BA (base) ↑ → degree of dissociation (α) ↑:

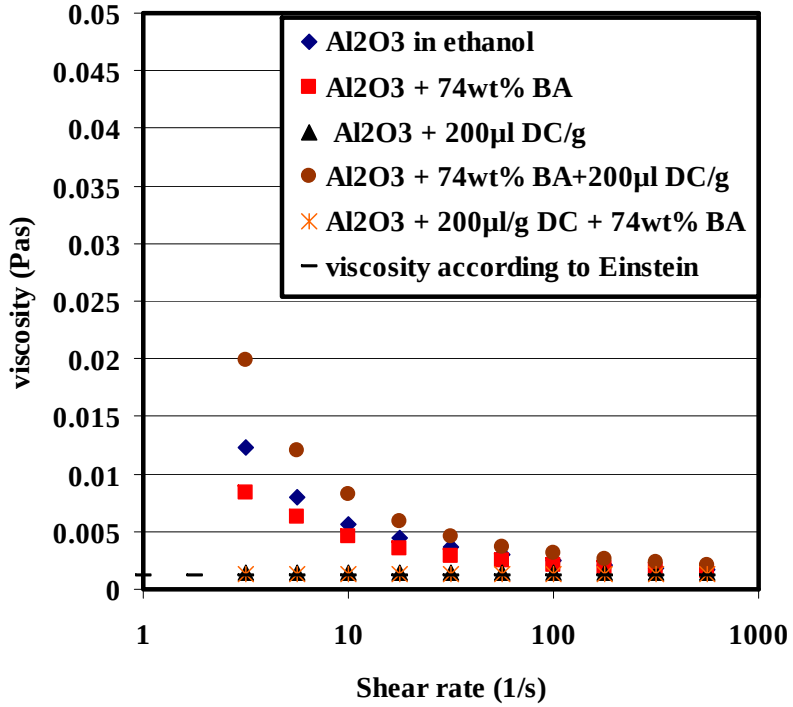
  $-COO-NH_4^+ \rightarrow -COO^-$
- n-Butylamine (BA) (for DC dissociation)

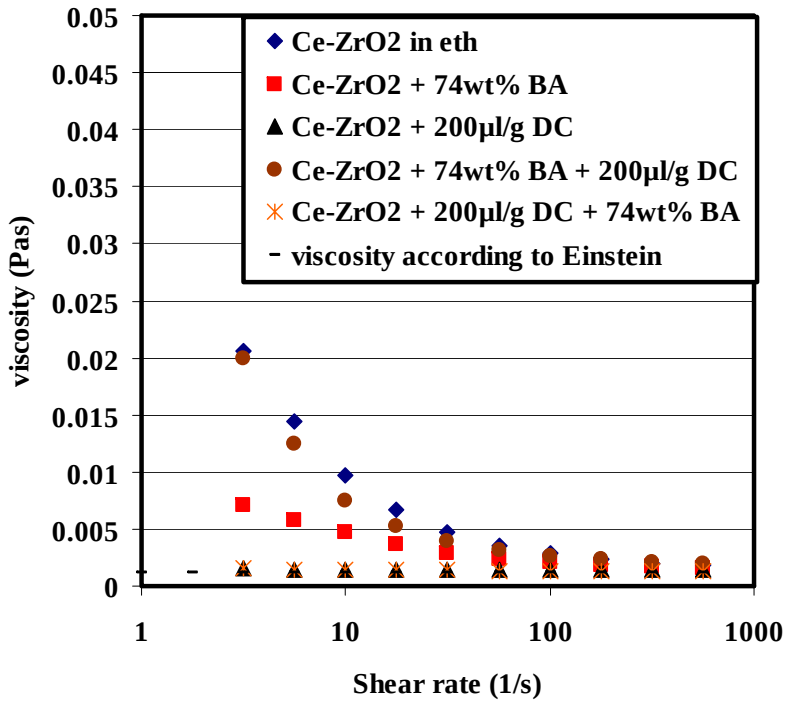
➡ Suspension viscosity investigated as function of the addition sequence of BA and DC

Suspension characteristics

Influence of BA and DC addition sequence on η at ↑ BA content

Suspensions: 2.5 vol % Al_2O_3, 1.5 vol % Ce-ZrO_2



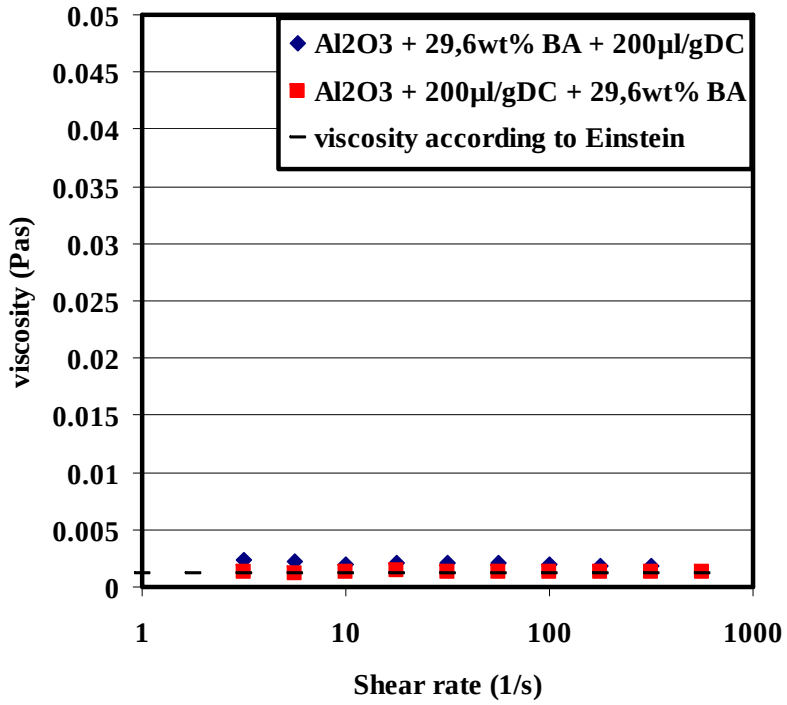


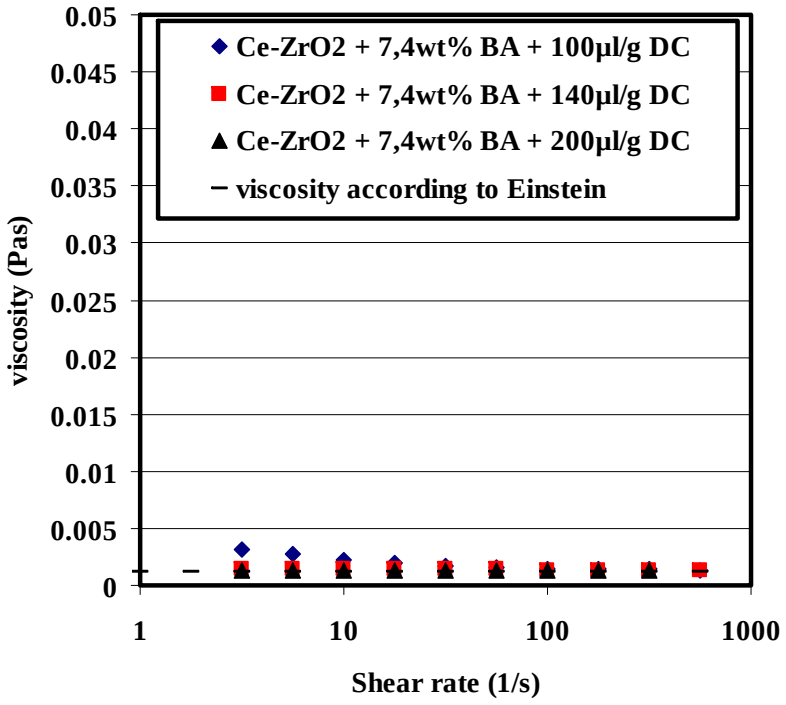
When BA first added compound → ↑ η, unstable suspension

When DC first added compound → ↓ η, stable suspension

Suspension characteristics

Influence of BA and DC addition sequence on η at ↓ BA content



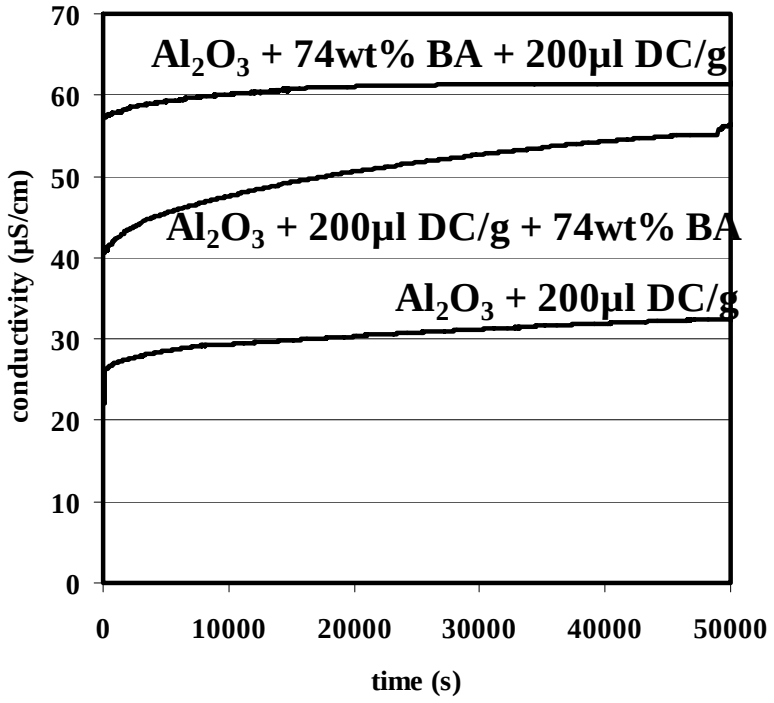


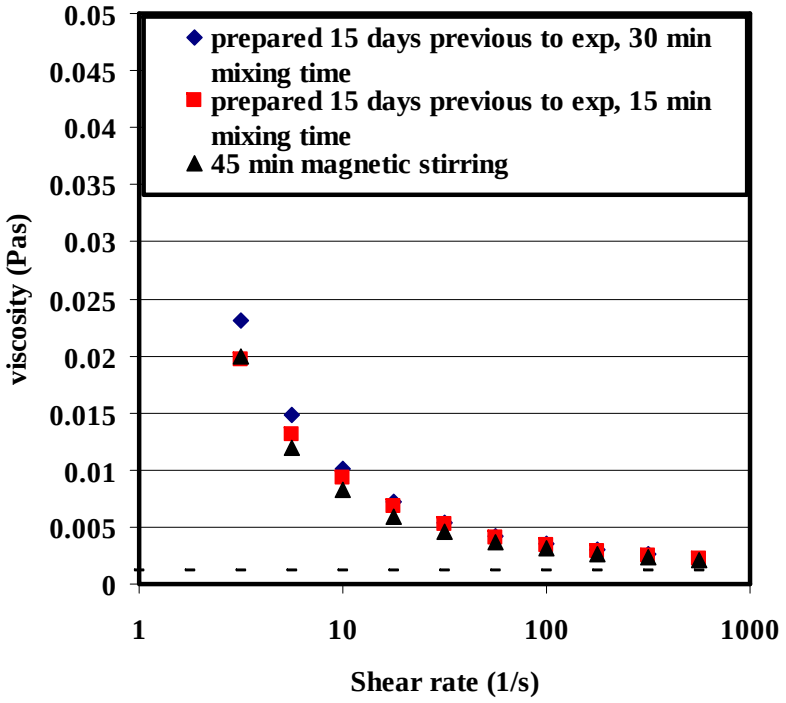
↓ η with ↓ BA, lower BA content, stable suspensions

BA content influences η more then the DC content and the addition sequence

Suspension characteristics

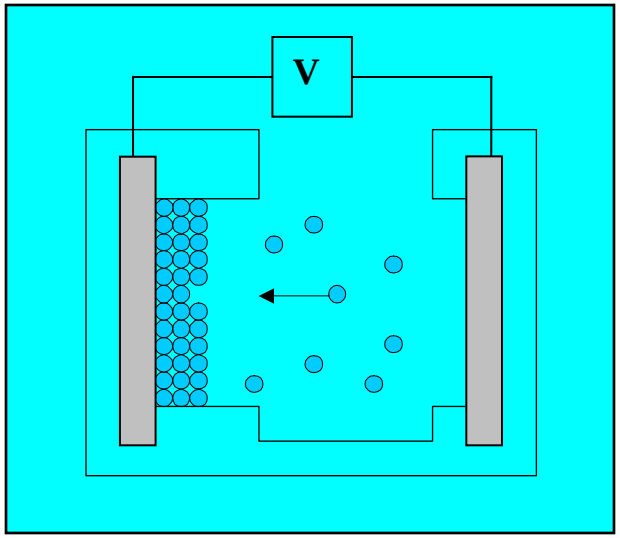
Suspension for a deformable deposit: chemical stability in time





Constant conductivity and η in time → good chemical stability

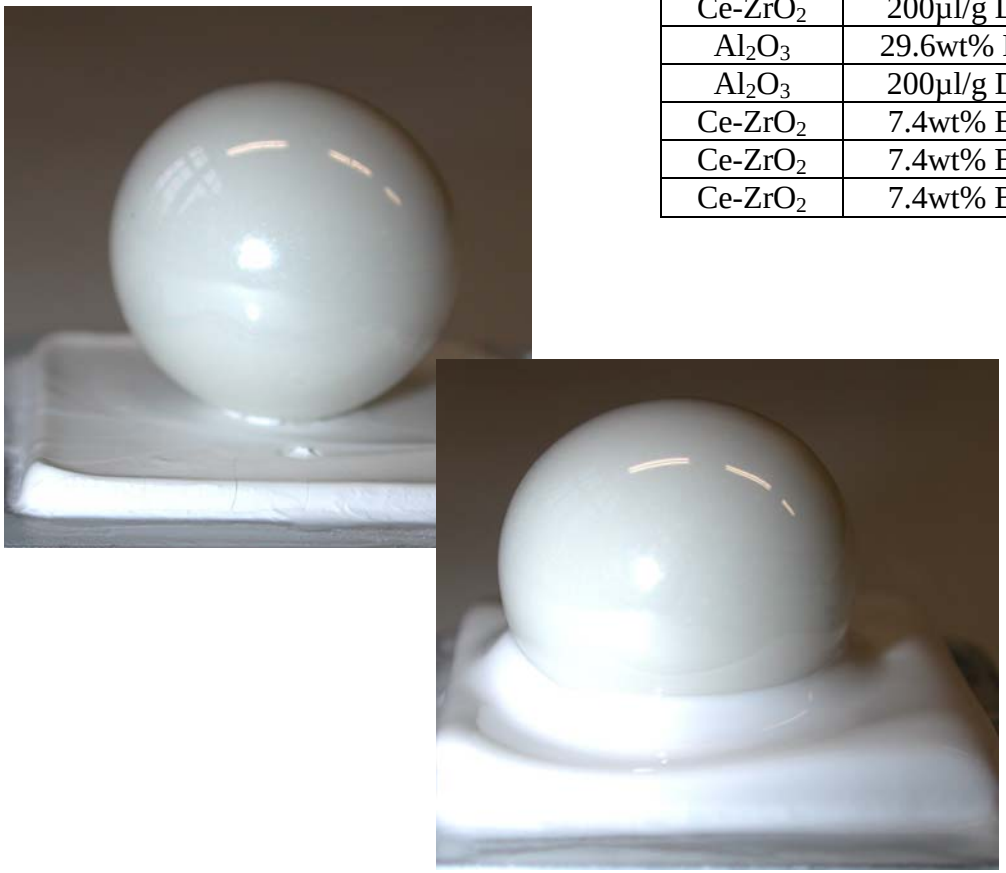
EPD conditions



- **300 V**
- **Magnetic stirring during EPD**
- **Vertical electrodes**
- **Stainless steel electrodes**
  distance 3.5 cm
  surface 9 cm^2

Deposit characteristics

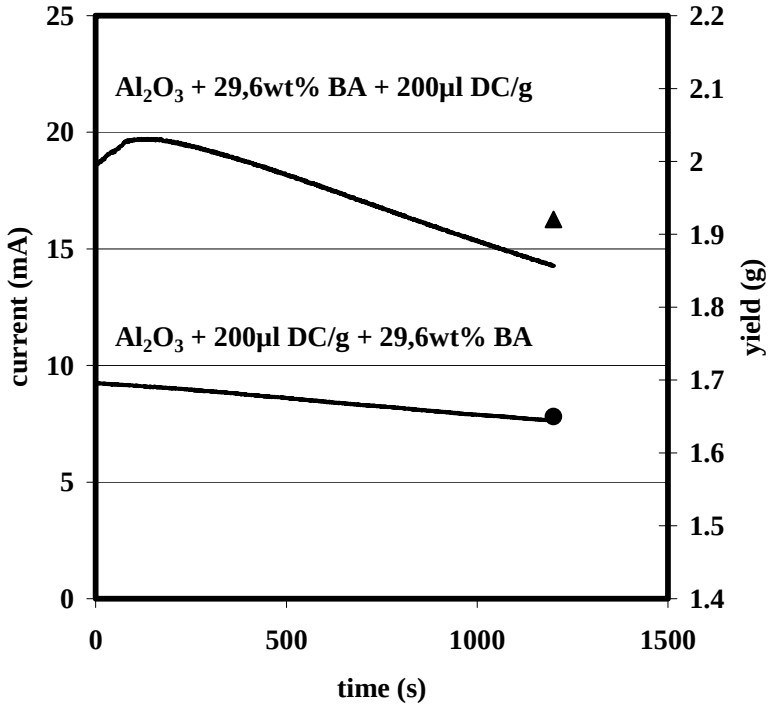
Powder	First added compound	Second added compound	Viscosity (Pas) at 3.16 s^{-1}	Deposit characteristics
Al_2O_3	74wt% BA	200µl/g DC	0.0199	Deformable
Al_2O_3	200µl/g DC	74wt% BA	0.0013	Rigid
Ce-ZrO_2	74wt% BA	200µl/g DC	0.0199	Deformable
Ce-ZrO_2	200µl/g DC	74wt% BA	0.0015	Rigid
Al_2O_3	29.6wt% BA	200µl/g DC	0.0023	Deformable
Al_2O_3	200µl/g DC	29.6wt% BA	0.0013	Rigid
Ce-ZrO_2	7.4wt% BA	100µl/g DC	0.0031	Deformable
Ce-ZrO_2	7.4wt% BA	140µl/g DC	0.0015	Deformable
Ce-ZrO_2	7.4wt% BA	200µl/g DC	0.0013	Deformable

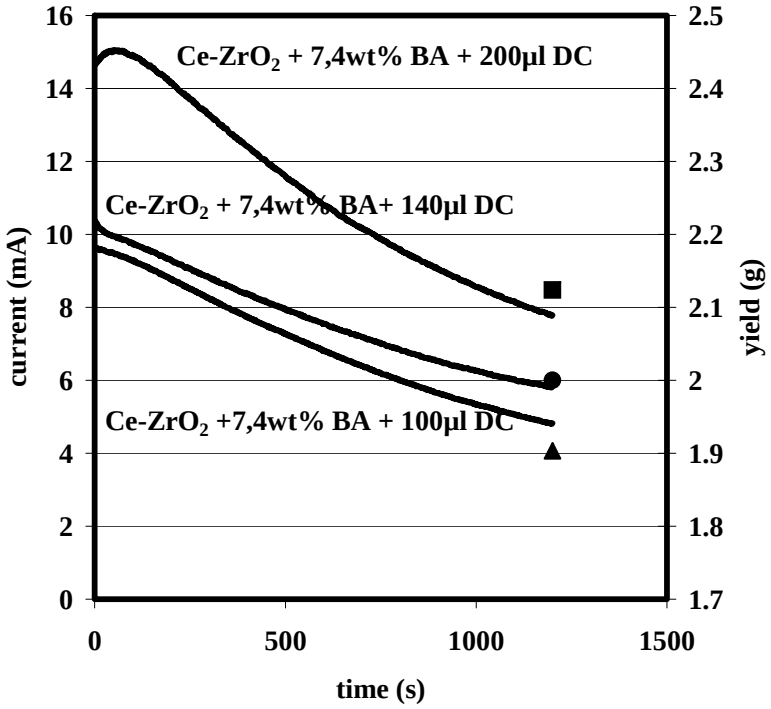


BA first added compound →
deformable deposit
DC first added compound →
rigid deposit

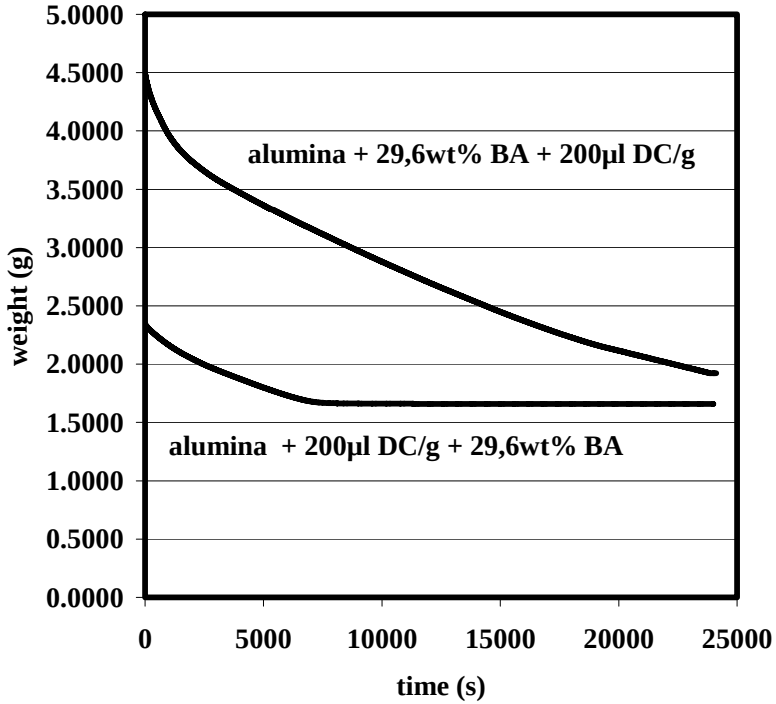
Electrophoretic deposition

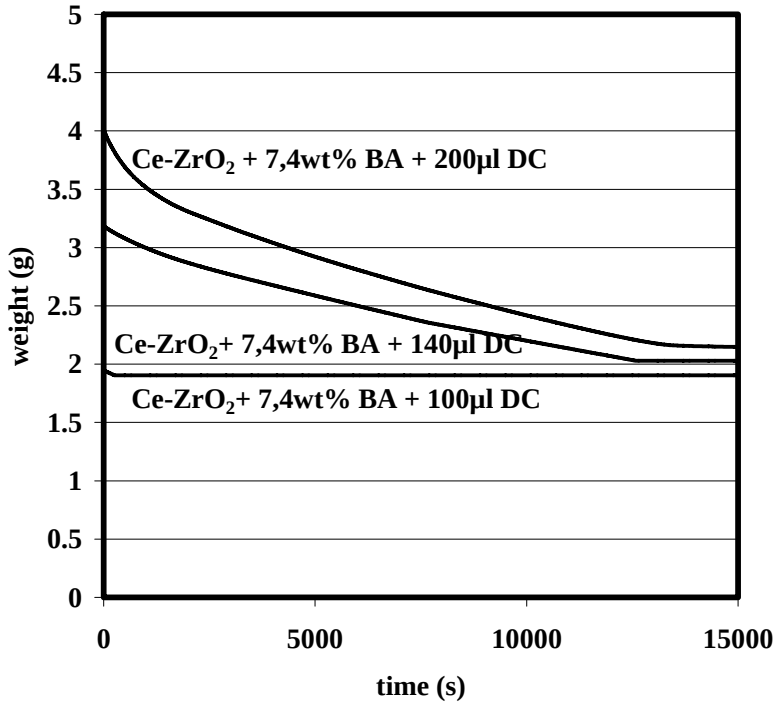
Current: BA first added > DC first added
BA constant and DC ↑ → Current ↑, Yield ↑





Drying





Drying time when BA added first >> DC added first

BA first added compound

BA constant drying time ↑ with ↑ DC content

Density

- **Small influence of BA & DC addition sequence or content**
- **Large influence of particle characteristics**

Relative density Al_2O_3 deposits ~40%
Relative density Ce-ZrO_2 deposits ~20%

Al_2O_3 is µm sized (0.6 µm)→ packing ↑
Ce-ZrO_2 is nm sized → packing ↓

Conclusions

- **Suspension stability**
  - **At ↑ BA content:**

    BA first added: unstable suspensions (possible network formation by free polymer bridges)

    DC first added: stable suspensions
  - **At ↓ BA content:**

    no influence of addition sequence, stable suspensions

Conclusions

➢ Deposit characteristics

- **BA first added → deformable deposit**
- **DC first added → rigid deposit**
- **drying time ↑ as BA and/or DC ↑**
- **Similar behavior of Al_2O_3 and Ce-ZrO_2 suspensions**

Acknowledgements

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