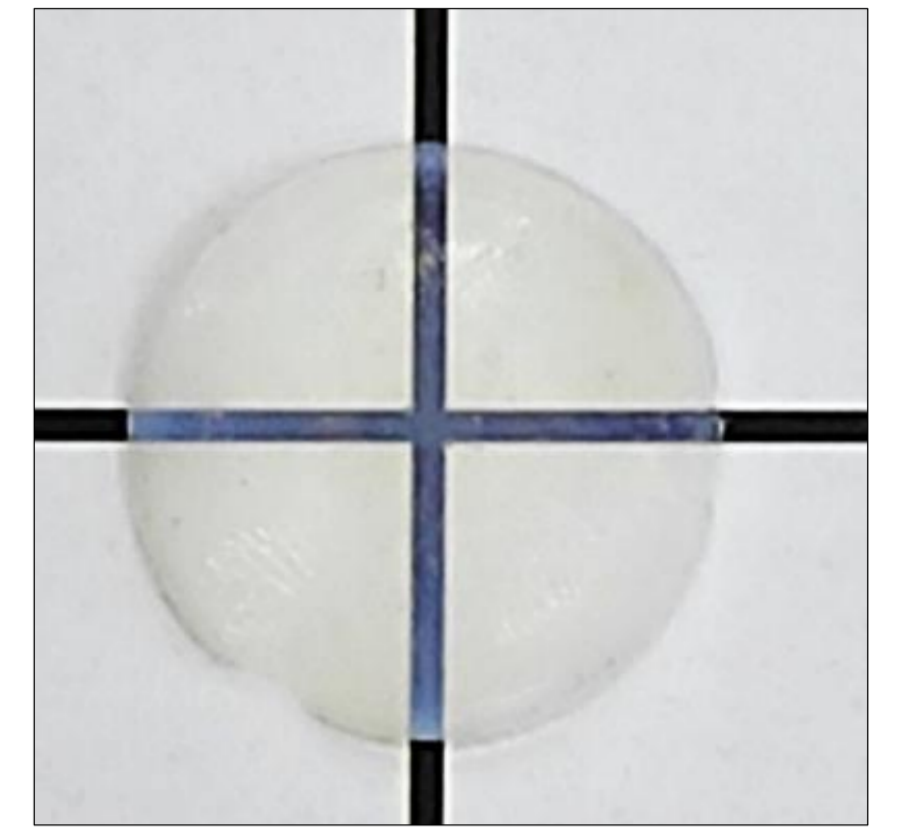


# Transparent Cellulose Aerogels from Concentrated Salt Solutions

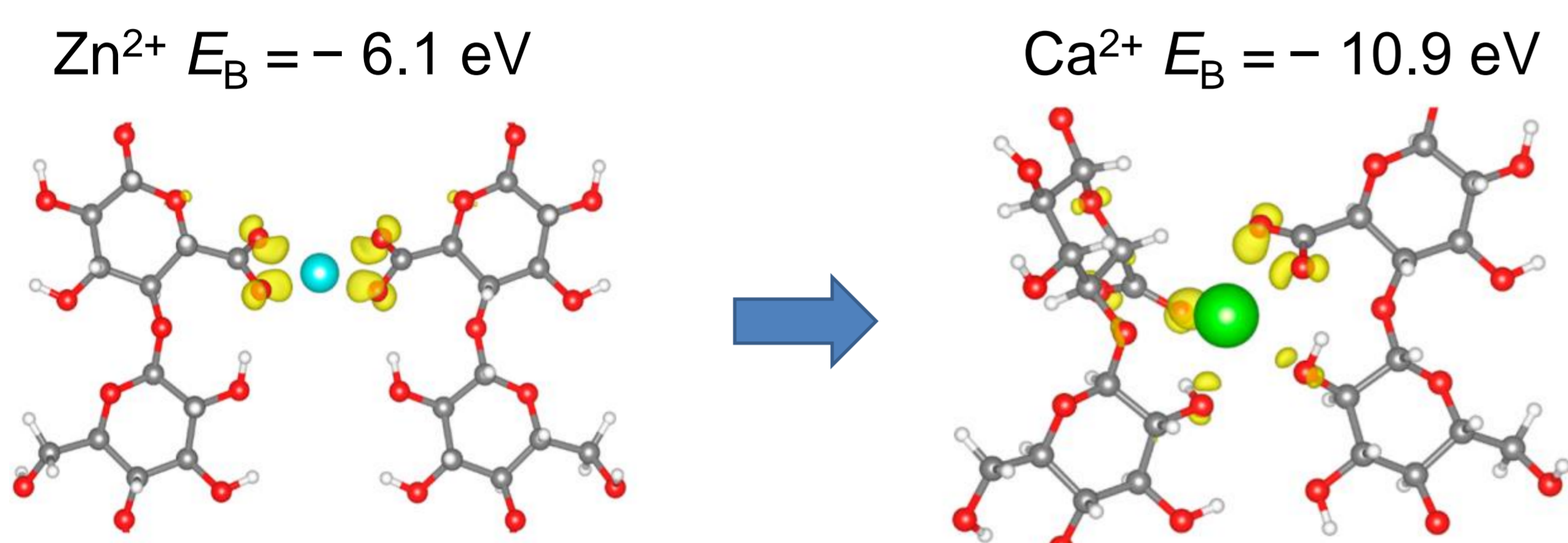
B. Schroeter, S. Holst, P. Gurikov, I. Smirnova

## Outline & Motivation

- Combination of aerogels properties with optical transparency opens up new application fields
- Only few examples for transparent biopolymer aerogels up to now
- Transparency demands high structural control (building blocks  $\leq 50$  nm)
- Our approach:  $\text{Ca}^{2+}$ -crosslinking of cellulose dissolved in  $\text{Zn}^{2+}$ -based molten salt hydrate

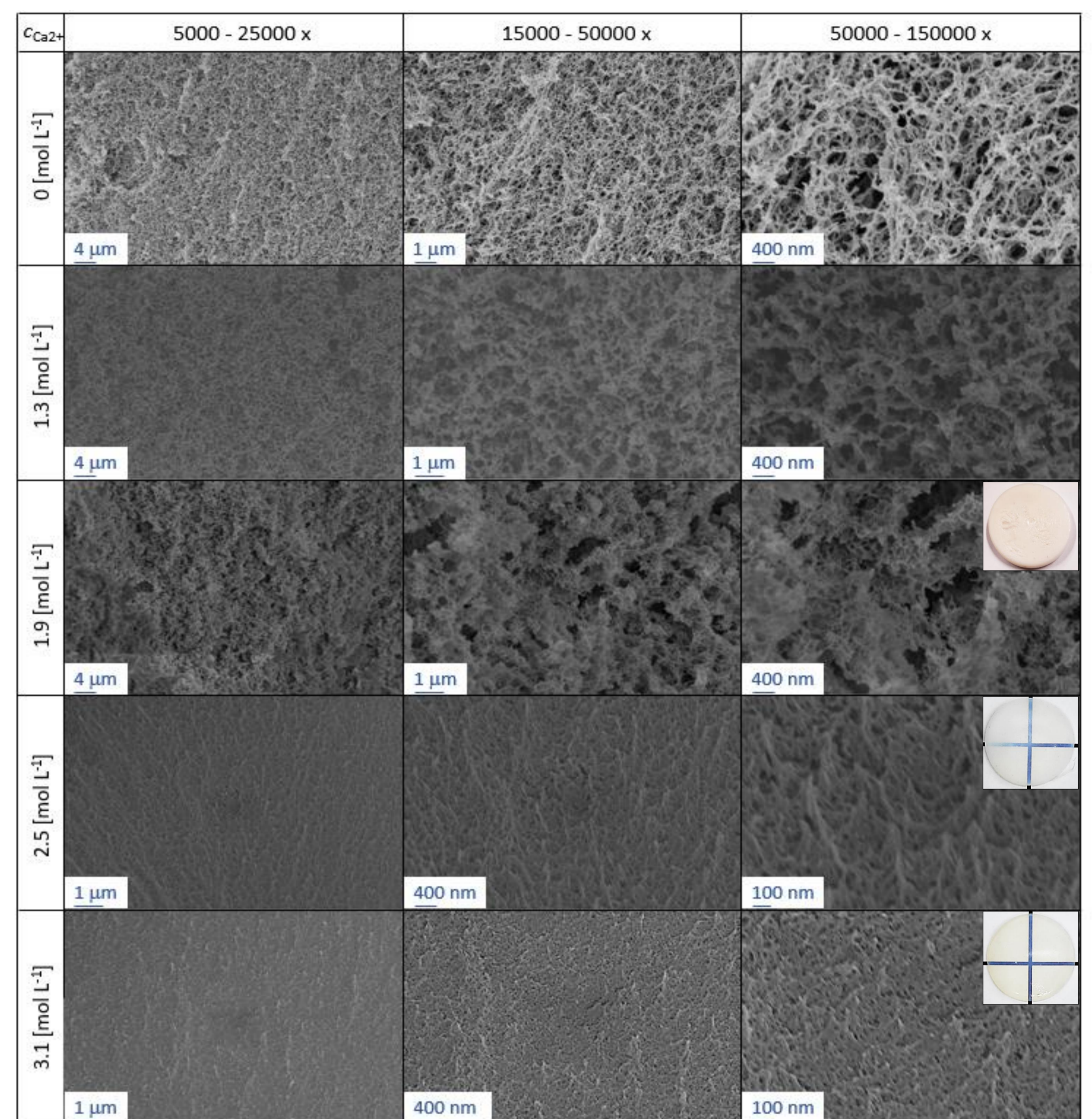


## Approach



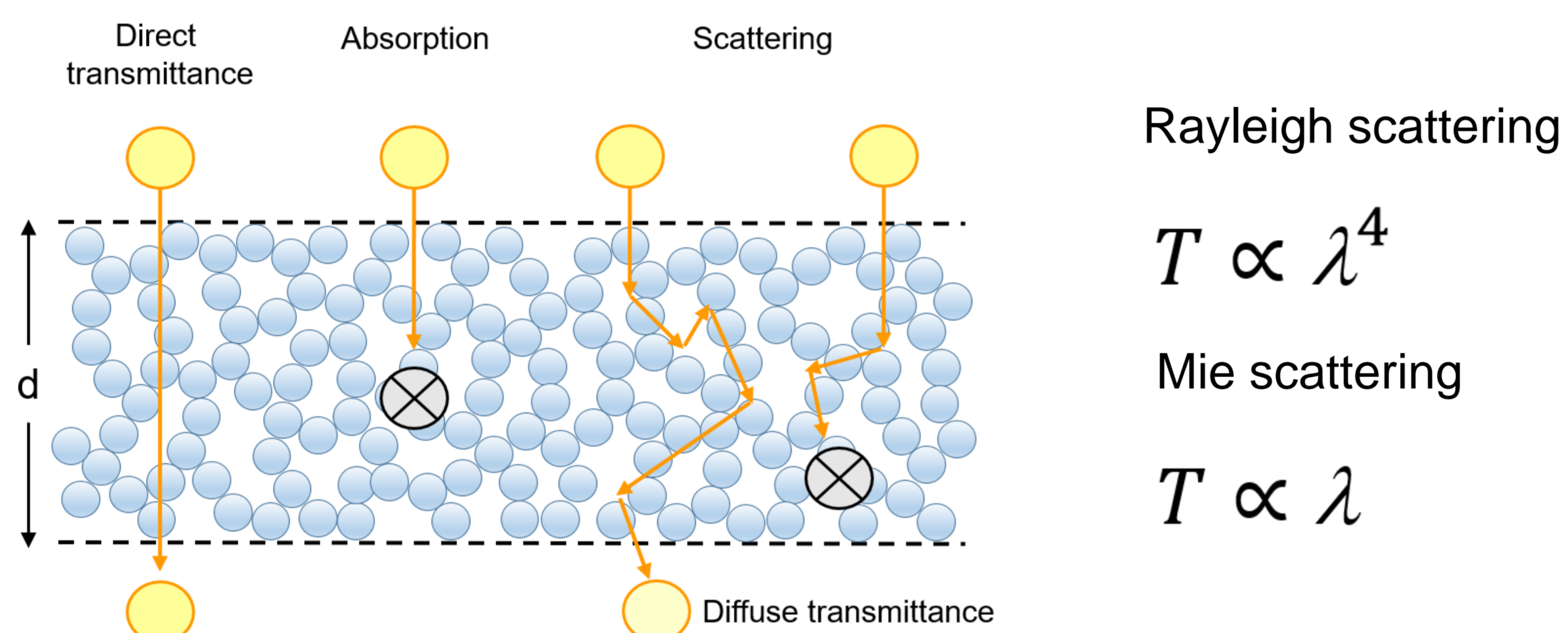
**Fig.1** Interactions of  $\text{Zn}^{2+}$  and  $\text{Ca}^{2+}$  with cellulose chains based on DFT-calculations.<sup>[1,2]</sup> Yellow regions represent gain of electron density.  $\text{Zn}^{2+}$ -ions can break the strong  $\text{O3H}\cdots\text{O5}$  hydrogen bonds. Water can penetrate the network, leading to dissolution of cellulose.  $\text{Ca}^{2+}$ -ions show comparably higher binding energy to cellulose and are able to crosslink adjacent Zn-cellulose chains.

## Microstructural Control



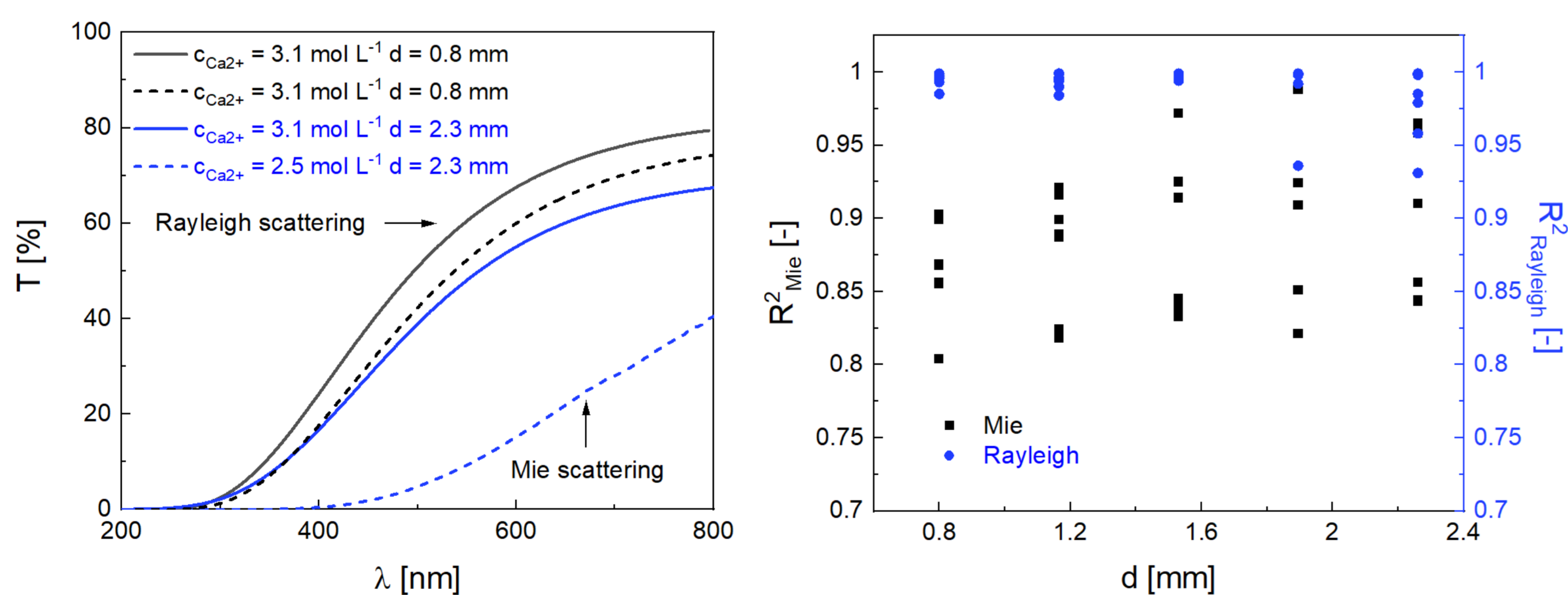
**Fig.4** SEM Pictures of cellulose aerogels produced at different  $\text{Ca}^{2+}$ -concentrations. High  $\text{Ca}^{2+}$ -concentrations result in fine, homogeneous structures, with small mesopores and no without macroporous defects.

## Light Scattering Mechanisms



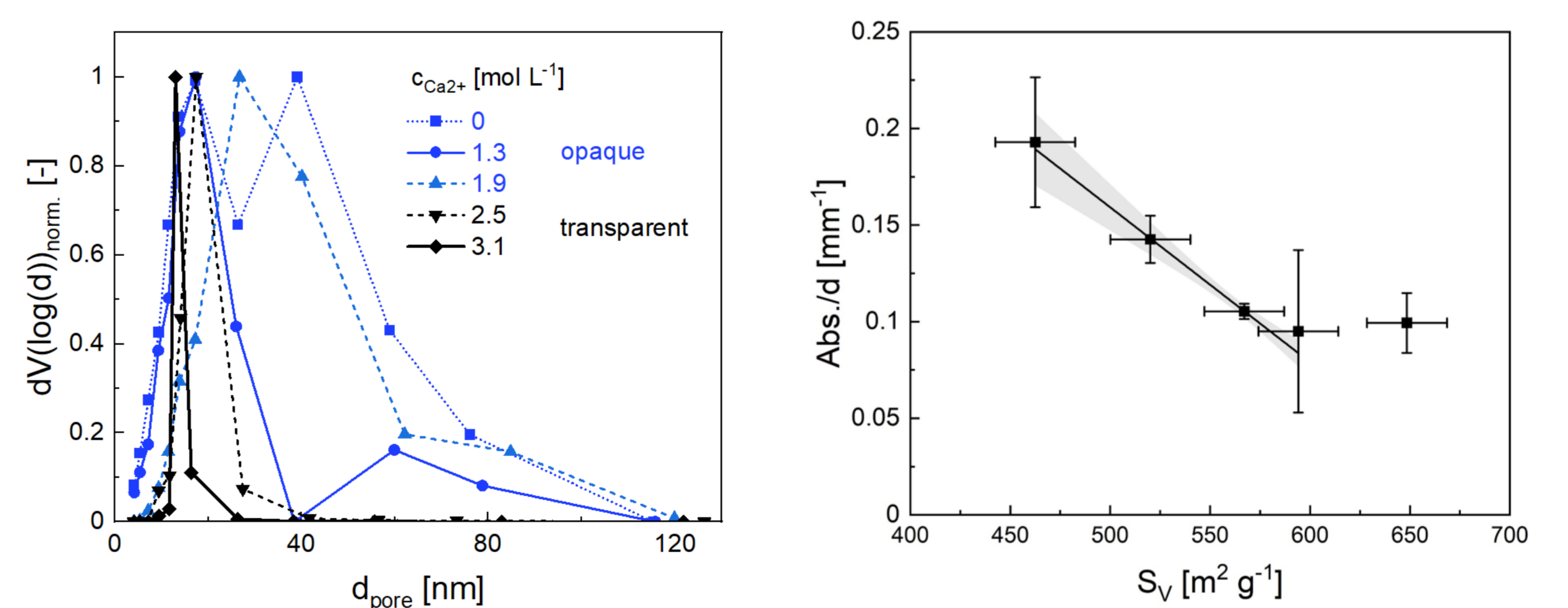
**Fig.2** Interactions of light with aerogel matrix. The dominating scattering mechanism depends on the ratio of scatter size and wavelength  $\lambda$  of the incident light. In order to avoid Mie-scattering, spatial inhomogeneities in the matrix must be avoided.

## Optical Properties



**Fig.3** Light transmittance in dependence of wavelength (left) and dominating scattering mechanism in dependence of substrate thickness (right). Thicker substrates show higher contribution of Mie-scattering.

## Textural Properties



**Fig.5** Pore size distributions obtained at different levels of  $\text{Ca}^{2+}$  (left). Relation between optical density per mm substrate thickness and specific surface area (right).

- Purely salt induced preparation of transparent cellulose aerogels; no need for expensive/harsh solvents or modification of cellulose
- First example of  $\text{Ca}^{2+}$ -crosslinked cellulose aerogels. Approach principally transferable to other metal cations.
- Max. transmittance = 85% ( $d = 0.8 \text{ mm}$ ,  $\lambda = 800 \text{ nm}$ ),  $S_V = 650 \text{ m}^2 \text{ g}^{-1}$ , meso pore volumes up to  $7.5 \text{ cm}^3 \text{ g}^{-1}$