

## Effect of Organic Modifiers on the Solution Viscosity, Gelation Time and Progress of Hydrolysis/Condensation Reactions during Hybrid Gels Formation

K. Cholewa-Kowalska<sup>1</sup>, M. Laczka<sup>1</sup>, Z. Olejniczak<sup>2</sup>

<sup>1</sup>AGH-University of Science and Technology, Faculty of Materials Science and Ceramics, Department of Glass Technology and Amorphous Coating, Al. Mickiewicza 30, 30-059 Krakow, Poland

<sup>2</sup>Institute of Nuclear Physics, ul. Radzikowskiego 152, 31-342 Krakow, Poland

Inorganic-organic hybrid gels are new nanometric materials where coexistence, on molecular scale, inorganic structures in the form of silica-oxide network and organic structures basing on carbon links. Properties of these hybrids are intermediate between inorganic glasses and organic polymers and depend on the kind and amount of units, building their structure. Moreover, the structure and properties of hybrids are determined by the progress of hydrolysis and polycondensation reactions during gel formation.

The objective of this work is to study the effect of the type of organic modifiers on the rheological property of the alkoxide solution and structure of the obtained organic –inorganic gels.

Five different kinds of hybrid materials produced by sol-gel method, all identical in terms of production procedure, but differing in terms of organic modifiers, have been examined. Tetraethoxysilane was used as the inorganic precursor and methyltrimethoxysilane (MTMS), vinyltriethoxysilane (VTES), phenyltriethoxysilane (PhTES), diethoxydimethylsilane (DEDMS), diethoxymethylvinylsilane (DEMVS) as organic modifiers.

The viscosity of the solutions was measured at 20 °C using a Brookfield viscometer. The gelation time was recorded for each of the sols. The progress of hydrolysis and polycondensation reactions was examined for wet gels, gels dried at ambient conditions and gels after treatment at 40 and 100 °C. As a method of examinations FTIR spectroscopy and <sup>29</sup>Si MAS NMR spectroscopy were used.

From our result it follows that the introduction of unhydrolysable organic groups retards the sol-gel process (longer gelation time) and act as fillers in the silica network, leading to the condensation of the obtained gels. It has been also found that hydrolysis reaction of hybrid gels proceeds mainly in solutions and polycondensation of gels, in the presence of organic modifiers, is more advanced than in the case of TEOS without addition of modifiers. Moreover, copolymers are formed between structural units of Si atoms in TEOS (Q) and in organic modifiers (T, D).