Scientific Contributions

of Assoc. Prof. Lachezar Radev

for the academic position "Professor" in the scientific field 5. 10. Chemical Technologies (Technology of Inorganic Materials)

*

The main thematic areas of the Contributions could be summarized as follows:

1. Preparation of glasses and glass-ceramics by the sol-gel method [3, 7, 9, 14-16, 19, 24, 30, 33] and solid-phase synthesis of dyes [2].

2. Inorganic-organic composite materials with the participation of glasses and glass-ceramics [4, 6, 10-13, 25 29, 34], silica [5] and composites without inorganic component [20, 21].

3. Catalytic systems synthesized by the sol-gel method [1, 8, 23].

4. Complex compounds with different central complexing agents (CCAs) and organic ligands [17, 18, 22, 28, 35].

5. Review publications on sol-gel glasses and glass-ceramics [26, 27, 31, 32].

A more detailed review of the scientific papers, according to the 'contributions' is summarized in Table 1.

Table 1. Distribution of scientific papers by "contributions"

Type of contribution	**Number of the scientific paper**
Applied research	1-16, 19-21, 23-25, 29, 33-34
Fundamental research	17, 18, 22, 28, 35
Other	26, 27, 31, 32

*

The production of glasses and glass-ceramics is based on sol-gel technology, which has extensively been used for this purpose.

The novelty of the sol-gel method developed by me 15 years ago is that it is a ***multistage process.*** Thus**,** the scientific papers presented for this academic competition take into account the production of bi- and three-phase glass-ceramics in the $CaO-SiO_2-P_2O_5$ system with (or without) the addition of other oxides, as well as sol-gel glasses, some of which indicate the presence of crystalline phases, even at low stabilization temperature (600 ° C).

The presence of several *in vitro* bioactive crystalline phases in glass-ceramics is a potential prerequisite for increased ***in vitro*** bioactivity and, hence, for presumably higher activity to specific cell cultures.

Table 2 presents ***the new sol-gel synthesized glasses and glass-ceramics*** reported in the scientific papers submitted for this academic competition for the occupation of the academic position "Professor".

Table 2.Summary of the data on the new synthesized *in vitro* bioactive glass-ceramics and gel-glasses by sol-gel technology

N	Initial gel composition	Thermal treatment	Phasecomposition	Changesafterthe*invitro*test
Bioactive glass-ceramics				
3	$15CaO-0.5P_2O_5-6SiO_2$ (mol)	1200ºC/2 h	$Ca_{15}(PO_4)_2(SiO_4)_6$ and $Ca_2SiO_4.0.05Ca_3(PO_4)_2$	Formation of CO_3HA-bio apatite.
9	$Ca_{10-x}Na_x(PO_4)_{6-y-2z}(SiO_4)_{y+z}(CO_3)_{x+z}(OH)_{2-y}$	1300ºC/2 h	Silicon-substituted apatites	Formation of CO_3HA-as a function of the SiO_2 contentin
14	$70.6CaO-1.18P_2O_5-28.2SiO_2$(wt.%)	1200-1500ºC	Depending on the temperature of thermal treatment$Ca_{15}(PO_4)_2(SiO_4)_6$ и Ca_2SiO_4 are observed	Formation of B-CO3HA, in co-presence with A and A/B-CO_3HA.
15	$3CaO-MgO-2SiO_2$ (mol)	1300ºC/2 h	Ca_2SiO_4 и $Ca_2MgSi_2O_7$	Formation of CO_3HA-bioapatite.
16	$3CaO-MgO-2SiO_2$ (mol)	1100ºC/2 h	Ca_2SiO_4, Ca_2SiO_4, $Ca_2MgSi_2O_7$, MgO	
17	$38CaO-31P_2O_5-29SiO_2-2MgO$ (wt.%) $55CaO-22P_2O_5-20SiO_2-3MgO$ (wt.%)	1200ºC/2 h	Depending on gel composition: for composition1 - $Ca_3(PO_4)_2$ and SiO_2; for composition 2 - $Ca_5(PO_4)_3SiO_4$, $Ca_2MgSi_2O_7$ и $Ca_3MgSi_2O_8$	Formation of CO_3HA-bioapatite coexisting with $Mg5 (CO_3)_4 (OH)_2.4H_2O$-hydromagnesite.
30	$2CaO-MgO-2SiO_2$ (mol)	1000, 1100 и 1300ºC/2 h	$Ca_2MgSi_2O_7$,$Ca_3MgSi_2O_8$ and $CaMgSi_2O_8$	Formation of CO_3HA-bioapatite.
Bioactive sol-gel glasses				
7	$30CaO-70SiO_2-xNbF_5$, where x=1, 3 и 5 % NbF_5 (wt.%)	700ºC/6 h	At 5% NbF_5 – $Nb_2Ca_{14}(Si_2O_7)_4O_8F_2$	Formation of CO_3HA-bioapatite. Its quantity depends on the content of Nb^{5+}
10	$85SiO_2-10CaO-5P_2O_5$(wt.%)	700ºC/3 h	$Ca_2P_2O_7$ with a recognized formation mechanism	Formation of mixed A / B-CO_3HA- with lamellar-agglomerate structure
24	$70SiO_2-25CaO-5P_2O_5-xAg_2O$, където x=1, 2	600ºC/6 h	At 4% Ag_2O – $CaSiO_3$ and $Ca_5(PO_4)_3OH$	Formation of CO_3HA-bioapatite

	and 4 % Ag_2O (wt.%)			

As can be seen from the data in Table 2, the resulting sol-glasses and glass-ceramics are *in vitro* bioactive, which means that they form carbonate apatite (CO3HA), and in particular the B-type, on their surface,which is considered bioapatite. The test used to prove their bioactivity is known as the "Kokubo" test. It is performed in simulated blood plasma (SBF) solution under static conditions.

The preparation of inorganic-organic ***composite materials*** involving the synthesis of sol-gel glasses and glass-ceramics aims to investigate both their structure – using routine methods for analysis – as well as the ability to form CO_3HA on their surface in SBF solutions, using procedure similar to the test performed with ceramics and sol-gel glasses.

Three works are outside this scope of scientific production [5, 20, 21], but two of them [20, 21] also investigate the *invitro* bioactivity of the obtained composites.

Asin the previous case, the tested composite materials have exhibited high *in vitro* bioactivity, which leads to the conclusion that they could be utilized in the field of bone regenerative medicine.

The sol-gel synthesized ***catalysts*** are the topic of three scientific papers. The synthesized catalyst systems have been investigated in real chemical processes, which leads to the conclusion that the obtained catalysts are of potential technological applicability.

Complex compounds with different CCs and ligands have been synthesized by us and their formation has been investigated using quantum mechanical methods, and a correlation between it and the activity of the complex is sought. This could serve as a real basis for their further applications.

Finally, the four ***review publications*** [26, 27, 31, 32] aim to summarize the place of my scientific production and the achievements in the field of sol-gel glasses and glass-ceramics.

Assoc. Prof. Lachezar Radev