The only major difference in formulation between the two compounds is that Bioglass 45S5 glass contains phosphorus in addition to the other elements. It would therefore be the phosphorus that is responsible for the greater thickness of the HCA layer on Bioglass 45S5. The HCA layer is thus more easily deposited on glass containing phosphorus.

The hypothesis would be that, initially, the glass releases phosphorus into SBF and this phosphorus could then participate in the nucleation of the HCA layer in the same way as the phosphorus present in SBF.

Nevertheless, the HCA layer does not evolve after these 10 days of soaking. Indeed, if Bioglass 45S5 is soaked for 20 or 40 days, it does not produce a thicker HCA layer.

Finally, in the $SiO_2$-CaO-$Na_2O$ system, the most bioactive glasses are those with low silica content (<45 mol% $SiO_2$) and high sodium content (>31.5 mol% $Na_2O$).

In view of the results obtained above, the study of the glasses of the ternary $SiO_2$-CaO-$Na_2O$ has been continued by first doping them with phosphorus. Indeed, there is certainly an ideal rate of phosphorus to insert into the vitreous network to optimize bioactivity.

## 3.2 DOPING OF GLASSES OF THE $SiO_2$-CaO-$Na_2O$ SYSTEM BY $P_2O_5$ (LEBECQ ET AL., 2007; LEBECQ, 2002)

### 3.2.1 Overview

Glasses, belonging to more complex systems, have been already studied (Andersson et al., 1990; Brink et al., 1997). Some studies indicate that phosphorus does not improve bioactivity, while others show that small amounts of phosphorus significantly improve bioactivity (Andersson et al., 1990, 1998; Hench et al., 1999a; Ohtsuki et al., 1992; Lim et al., 1989; Rehman et al., 1994; Vallet-Regi et al., 1999).

It is evident that the addition of $P_2O_5$ allows the soaking medium to be oversaturated with phosphorus and precipitation to be facilitated. But, it is not limited to this role. It also affects the nucleation of crystals, their size, and the rate of crystallization. Its quantity should not be too great, which would risk causing a negative effect. A glass, with essentially phosphorus as the network former, cannot form a layer of silica gel, which is essential for the nucleation of the apatite layer.

The aim of this second part is to discuss the ideal rate of phosphorus to be added to the $SiO_2$-CaO-$Na_2O$ system, in order to optimize the bioactivity properties and to understand the influence of phosphorus on the glass.

### 3.2.2 Selection of Compositions

The ratio of phosphorus is defined using a molar percentage of $P_2O_5$, noted $x$. The molar compositions of $SiO_2$, CaO, and $Na_2O$ were recalculated to $(100-x)\%$ so as to keep the Si/Ca and Si/Na ratios unchanged in comparison with the ternary glass.