PHOTOOXIDATION OF POLYMER SYSTEMS UNDER STRESS. A NEW APPARATUS.

Francesco Paolo La Mantia

Department of Civil, Environment, Aerospace and Materials Engineering

University of Palermo, Viale delle Scienze, 90128 Palermo, Italy

(francescopaolo.lamantia@unipa.it, www.dicpm.unipa.it/lamantia)

The photo-oxidation of polymers is usually investigated by measuring the changes of some properties (mechanical, structural, morphological) as a function of the irradiation time. Moreover, in the apparatuses for accelerated ageing the samples are stress free, so they do not give any indications about the effect of the applied stress on the photo-oxidation kinetics.

The new apparatus[1] here presented overcomes these two shortcomings, indeed, the samples are irradiated under stress and the record of a mechanical property – the creep behavior – is monitored during the irradiation. In this way the change of the property can be seen during the irradiation itself and not after the irradiation and the real behavior of the polymer during the use is investigated. Of course, the change of the creep curve must be compared with the creep curve of the non irradiated sample.

The creep curve is the deformation undergone by a polymer sample subjected to a given stress. This is an important mechanical characteristic of the polymeric materials which, as it is well known, undergo a continuous deformation with time when a stress is applied on. The measurements can be made as a function of the irradiation time, of the applied stress and of temperature and humidity.

In the following, two examples are reported concerning the effect of humidity and stress on the creep behavior during UV irradiation of a polyamide 6 sample.

In Fig.1 the creep curves of the 95°C, 15% RH samples measured in the presence or not of UV irradiation are reported.

The UV irradiation increases the creep rate and intensity. The irradiated sample presents a maximum in the creep curve, but earlier respect to the non irradiated sample. After the maximum, instead of having a plateau-like

zone like in the irradiated sample, the strain increases until the end of the test. This behavior can be explained considering that UV provokes an increase of the degradation rate in the polyamide as confirmed by the intrinsic viscosity which, for this sample, is the lowest one among all the measured values. The decreasing of the molecular weight, that in the non-irradiated sample is only caused by the high temperature, in the irradiated sample is exalted by the photo-degradation. This earlier and more intense decrease of the molecular weight provokes and earlier maximum in the creep curve, but also an earlier yielding, thus explaining the increase of the creep in the last part of the test.

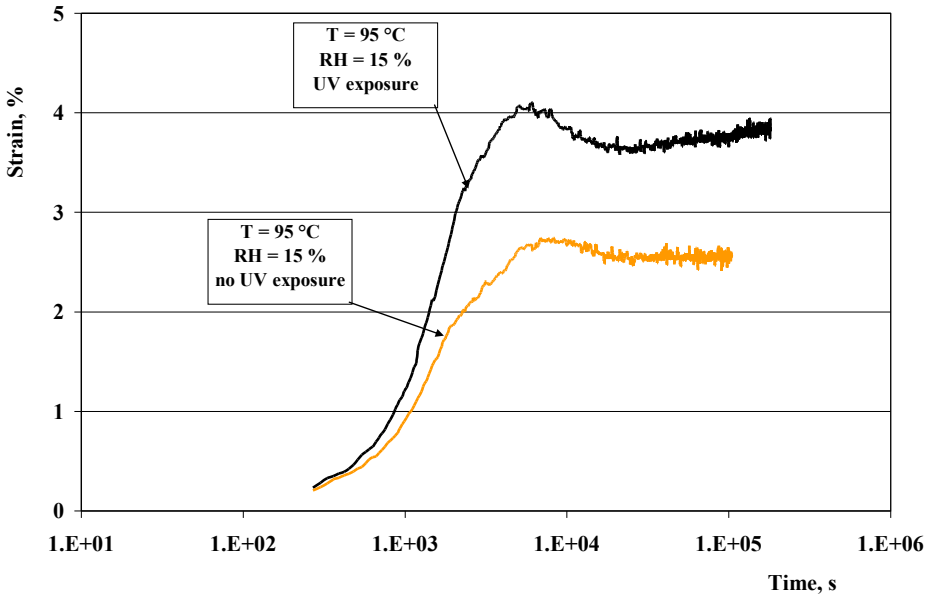

Figure 1 Creep curves of the 95°C, 15% RH samples measured in the presence or not of UV irradiation

The new apparatus allows to monitor the contemporary effects of the applied stress and of the photo-oxidation on the mechanical (viscoelastic) properties during the test itself and at the same time allows to have a sample for further characterization.

References

1. R. Scaffaro, N. Dintcheva Tzankova, F.P. La Mantia “A new equipment to measure the combined effect of humidity, temperature, mechanical stress and UV exposure on the creep behaviour of polymers” Polym. Testing, **27**, 49-54 (2008)