Development of an innovative on-line ultra violet radiation pyrolysis-GC/MS (UV/Py-GC/MS) system useful for rapid and sensitive weathering test of materials

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The physical and chemical performances of most polymeric materials gradually degrade due to external effects such as heating, photoradiation, oxidative atmosphere and mechanical stress. During the degradation process, not only the decomposed compounds formed from the sample but also the structural alternation of the polymers has been important targets to analyze. By getting this information, it would be possible to prepare the advanced materials by modifying its molecular structures and/or selecting appropriate additives. For these analyses, innovative analytical methods have to be developed.

In this work, a new analytical instrument using an on-line micro-ultra violet (UV) radiator combined with the multi-functional micro-furnace pyrolyzer (PY-2020iD, Frontier Lab, Japan) attached to a capillary column GC/MS was developed. A UV beam was radiated on a small amount of polymer sample set in the pyrolyzer through a fiber cable under oxidative and slightly heating atmosphere. The trace amounts of evolved gases from the irradiated polymer sample were on-line analyzed by GC/MS, and then the residual polymer was pyrolyzed in the pyrolyzer at high temperature typically at 600˚C to give a specific pyrogram or subjected to conventional evolved gas analysis (EGA) typically by temperature programming up to 700˚C to give a thermogram in order to characterize the thermal characteristics. Based on both information obtained, the deterioration mechanism of the polymeric material during photo, thermal and oxidative decomposition and the effect of additives such as photostabilizer and UV-absorber can be evaluated using sub-milligram order of minute polymer sample with a relatively short test period. Here the basic performance of this system was examined using representative polymeric materials such as polystyrene and polycarbonate.