## A Catalytic Approach for Cationic Living Polymerization: Sc(OTf)<sub>3</sub>-Catalyzed **Ring-Opening Polymerization of Lactones**

## Nobuyoshi Nomura, Atsuko Taira, Takashi Tomioka,<sup>†</sup> and Masahiko Okada\*

Laboratory of Polymer Chemistry, Graduate School of Bioagricultural Šciences, Nagoya University, Nagoya, 464-8601, Japan

## Received September 15, 1999 Revised Manuscript Received January 21, 2000

Aliphatic polyesters with a narrow molecular weight distribution (MWD) are of great interest especially for medical applications.<sup>1</sup> Living ring-opening polymerization of lactones<sup>2</sup> has been reported for that purpose mostly in an anionic or coordinated anionic fashion,<sup>3</sup> whereas there have been rarely found successful cationic examples in the literature.<sup>4</sup> Even the reported cationic living polymerization of lactones is problematic for two reasons: (i) initiators are extremely air- and moisturesensitive; (ii) each molecule of the initiator produces, at most, only one molecule of polymer (Scheme 1a), and it is *stoichiometric* polymerization in the sense of the number of molecules. We describe herein a practical catalytic approach for cationic living polymerization of lactones using scandium trifluoromethanesulfonate, Sc-(OTf)<sub>3</sub>, as a catalyst commercially available, in which one reactive Sc(OTf)<sub>3</sub> molecule *catalytically* produces a large number of polymer molecules (Scheme 1b) and also in which contamination of protic compounds such as H<sub>2</sub>O and ROH does not suppress the catalytic activity of Sc(OTf)<sub>3</sub> for cationic polymerization (eq 1).

$$\begin{pmatrix} O \\ cat. Sc(OTf)_3 \\ H_x \\ cat. Sc(OTf)_3 \\ x = 1 \text{ or } 2 \\ 0 - 25 \text{ °C} \end{pmatrix} = M_{RO} \begin{pmatrix} O \\ H_x \\ H_x \\ H_x \\ O \end{pmatrix}_n^H (1)$$







(a) Living polymerization O: Reactive initiator or catalyst •: Monomer A : Inert additive

<sup>†</sup>Present address: Department of Chemistry and Biochemistry, University of California, Santa Barbara, CA 93106.