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EFFICIENT PREPARATION OF ALLYLIC GRIGNARD REAGENTS USING SLURRIES OF PRECONDENSED MAGNESIUM

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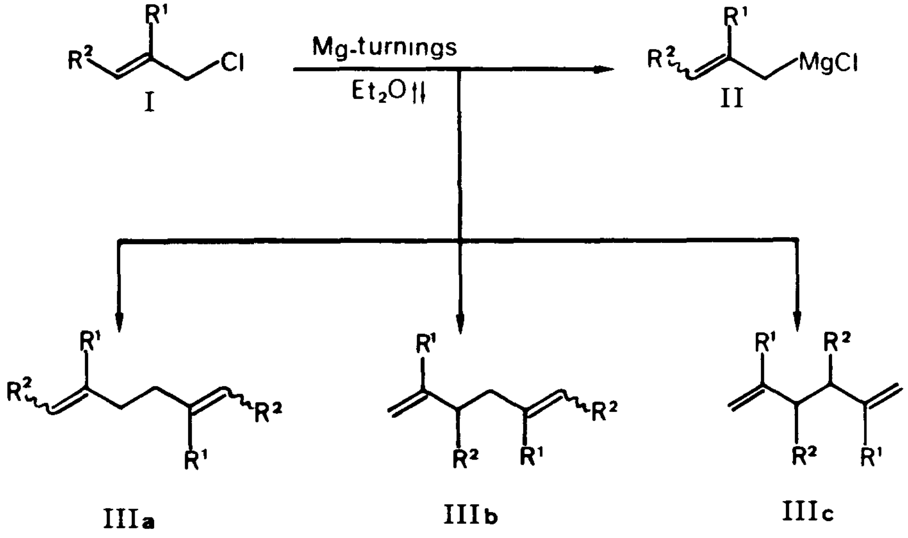
Abstract Using a simple apparatus addition of 2-alkenyl halides to precondensed active Mg in THF gave clean solutions of 2-alkenylmagnesium halides which on carbonation furnished β,γ-unsaturated carboxylic acids in high yields.

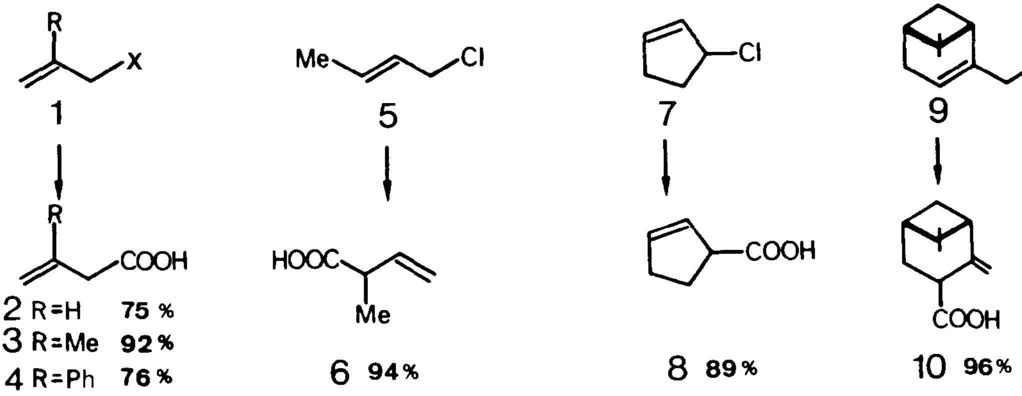
2-Alkenylmagnesium halides constitute a versatile class of synthetic intermediates; examples are transmetalation processes leading to σ-2-alkenyl[1] - or π-allyl[2]-metal compounds, direct substitution with a range of electrophiles[3], as well as inter-[4] and intra-molecular[5,6] ene-type reactions with C,C-multiple bonds. However, the preparation of the 2-alkenyl Grignard reagents II by direct metalation with an allyl halide I suffers frequently from the propensity of II to couple with unused halide I forming 1,5-hexadienes III[3] (Scheme 1).

Scheme 1



Among various procedures to minimize coupling the use of highly activated magnesium obtained by reduction of magnesium (II) halide with potassium[7] seems to be rather encouraging[8]. Our own attempts to submit the thus obtained slurries containing II to thermal intramolecular additions to olefinic bonds (60 to 130°C) led only to extensive polymerisation Therefore we turned our attention to the preparation of clean, alkali-metal and -halide free solutions of 2-alkenyl Grignard reagents employing extremely reactive magnesium suspensions obtained by evaporation of the metal into cooled THF. Although the conversion of allylbromide to allylmagnesium bromide (60% yield) by a related technique has been described previously[9] no other example is known. We report here a systematic study using a practical and simple rotating solution reactor[10] which allows successive generation of the active Mg-slurry, formation of the allylmagnesium chloride and trapping with CO_2 within the same reaction vessel. The following general procedure is representative. Magnesium (Alfa 99.95%. block, 1.70g, 70.8 mmoles) was evaporated at 0.01 Torr over a period of 1.5 h from a resistance heated alumina crucible and condensed into a surrounding layer of THF (60 ml) within a rotating reaction flask (1 *l*) cooled to -110°C. Slow addition (1.5 h) of the 2-alkenyl chloride (36 mmoles) in THF (40 ml) to the rotating black Mg-slurry under argon at -70° furnished the Grignard solution into which dry CO_2 was condensed at -110° for 5 min. The reaction mixture was kept at -70° for 0.5 h, then allowed to warm up to 0° and quenched with aq. NH_4Cl. Addition of ether, extraction with 10% aq. NaOH and re-extraction from the acidified aq. phase gave the corresponding carboxylic acid in high yield. Our results are summarised in Scheme 2[11].

Scheme 2



The observed formation of β,γ-unsaturated acids in excellent yields show the efficient suppression of the usually detrimental coupling reaction. No "dimers" III could be found in the neutral fractions obtained on work-up of the reactions 1, R = H, X = Br → 2, 1, R = Me, X = Cl → 3, 5 → 6 and 9[12] → 10. The latter case is particularly noteworthy in view of the reported failure to achieve this transformation using alternative methods[13]. Another interesting example is the efficient conversion 7 → 8 since the acid 8 served as a precursor for a direct synthesis of (+)-longifolene[14]. In this context we had invariably observed considerable coupling using the recommended classical procedure[3] particularly on working at a scale of ≦0.1 mole[15] In contrast, the method presented here furnished 8 in a reproducible yield of 89% together with only 1.2% of 3-(3'-cyclopentenyl)cyclopentene. It appears however that "dimer" formation becomes competitive on additional conjugation of the starting allylic chloride. Thus, the transformation 1 R = Ph, X = Cl[16] → 4 (76%) provides 2,5-diphenyl-1,5-hexadiene in 13% yield[17]. Nevertheless, the examples shown above demonstrate clearly an efficient and reliable route to 2-alkenylmagnesium halides containing no impurities which interfere with consecutive reactions. Reproducible results starting from 0.001 to 0.1 mole of even more intricate allylic chlorides[6] signify the potential value of this method for the synthesis of complex molecules.

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